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MAMMALS OF ROBINSON FOREST: SPECIES COMPOSITION OF AN ISOLATED, MIXED-MESOPHYTIC FOREST ON THE CUMBERLAND PLATEAU IN SOUTHEASTERN KENTUCKY

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MAMMALS OF ROBINSON FOREST: SPECIES COMPOSITION OF AN ISOLATED, MIXED-MESOPHYTIC FOREST ON THE CUMBERLAND PLATEAU IN SOUTHEASTERN KENTUCKY
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Introduction

The extensive Appalachian mountain system of eastern North America is comprised of a series of provinces, the westernmost of which is the Appalachian Plateau Province consisting of a series of distinct plateaus each supporting distinct faunal assemblages (see McFarlan, 1943; McGrain, 1983 for a more detailed description of physiography). This province includes the eastern 25% of Kentucky and is comprised of the Unglaciated Allegheny Plateau and the Cumberland Plateau. The Cumberland Plateau is characterized by a Pennsylvanian strata of shale, abundant coal deposits, and a relatively level layers of hard sandstone. The plateau is deeply furrowed with meandering streams of moderate gradients. Consequently, the region is a maze of deep and narrow valleys, steep slopes, and narrow winding ridges. In Kentucky, much of the Cumberland Plateau was subjected to extensive logging and coal mining. The landscape of most of the region was altered drastically as the sandstone-capped ridge tops were removed and deposited as fill in valleys. In areas where mining was completed, ensuing reclamation efforts attempt to "restore" and stabilize the land. Restored sites lack the original topsoil, but instead have compact rock rubble on the surface (Figgure 13*b*). These sites typically are planted with native grasses and a variety of native and exotic nitrogen-fixing legumes. Legumes are in the form of ground cover, bushes, and trees. Restored sites are distinctly different from unmined areas both physically and biologically. First, the ranges in elevation are reduced as a result of the combined practice of ridge top removal associated with valley fill. Additionally, valley fill practices destroy existing streams and create a series of sediment ponds and wetland habitats. Restored surface mines typically have greater diversity of microhabitats, ranging from: patches of hardwood forest in remaining valleys; to open habitat with variable floral assemblages of native and nonnative species; to extensive wetland habitat.

In Kentucky, the University of Kentucky's Robinson Forest represents one of the largest remaining forested areas with the original topography of the Cumberland Plateau. Robinson Forest is a 5,667 ha, second-growth forest located in Breathitt, Knott, and Perry counties in southeastern Kentucky with elevations ranging from 240 to 490 m. Robinson Forest is comprised of a main 4,085 ha tract and seven outlying tracts totaling 1,764 ha. During the 1990s, most of the smaller tracts were logged and mined, while the main tract of land was subjected to isolated mining. The main tract remains the most protected and least disturbed section of forest. Robinson Forest is a biologically unique habitat that is in a dynamic state. Forest fragmentation resulting from surface mining and logging on adjacent lands have turned Robinson Forest into a habitat island. Further, surface mining and reclamation efforts have created surrounding habitats not naturally characteristic of the Cumberland Plateau or Robinson Forest. These activities have created a large-scale disturbance that has influenced the mammal community of Robinson Forest over the last half of the 20th century. During this time, some species of mammals have become locally rare or extinct, while new species have invaded and become dominant in certain habitats (Krupa and Haskins, 1996).

Robinson Forest is undergoing ecological changes both naturally and in response to human activities. Currently, little quantitative information is available documenting how these changes are influencing the mammal community. Baseline data are essential to determine future ecological shifts that may occur in the region. The purpose of this study is to provide qualitative and quantitative data on the mammals of Robinson Forest. We collected field data from 1992 to 2001. We also include all published and unpublished mammal studies we could locate dealing with Robinson Forest. Our intent is for future studies to have a published database available for comparison. In this way it will be possible to document ecological changes.

HISTORY OF ROBINSON FOREST

The Cumberland Plateau has high commercial value in stands of hardwood forests, abundant coalfields, and extensive natural gas fields. The commercial value of the region has played a major role in the history of Robinson Forest. In 1908, F. W. Mowbray and E. O. Robinson purchased 5667 ha of virgin timberland in Breathitt, Knott, and Perry counties. The Mowbray and Robinson Lumber Company began logging soon after and continued until the property was completely logged in 1923. At that time, the E. O. Robinson Mountain Trust was established to promote reforestation. In October 1923, the land was conveyed with a stipulated trust to the University of Kentucky. The mineral rights were not conveyed. In 1924, the Kentucky General Assembly appropriated $25,000 annually for operation and management of Robinson Forest. Also in 1924, the first superintendent and forester were hired to map the forest, establish boundaries, inventory tree species, and develop a fire-protection plan (Overstreet, 1984).

In 1930, E. O. Robinson conveyed the mineral rights to the Commonwealth of Kentucky stipulating exclusive use and benefit would go to Robinson Forest. It was assumed at the time that this gift would remove any threat of coal mining to the forest. Most of the 1930s involved timber stand improvement and the establishment of tree plantations.

In 1940, construction of Camp Robinson began (Figure 1). Five rustic buildings were constructed using chestnut trees killed during the blight of the 1930s. World War II stopped construction of the camp, which did not resume until 1955. In 1947, a cooperative agreement with the State Department of Fish and Wildlife Resources was established to designate Robinson Forest as a wildlife restoration area. A stocking program began with the reintroduction of four games species that had been eradicated from the area. These were white-tailed deer (*Odocoileus virginianus*), beaver (*Castor canadensis*), wild turkey (*Meleagris gallopavo*), and ruffed grouse (*Bonasa umbellus*).

In 1971, the Vols Coal Company of Tennessee attempted to strip-mine a section of the forest but was prevented from doing so. In 1982, the University of Kentucky considered leasing part of the forest for mining. Due to public protest, the University of Kentucky Board of Trustees voted down any attempts to lease the forest for mining. In 1990, Arch Minerals Mining Company declared its intent to mine a northwest area of Robinson Forest. This was a section of the forest purchased by the University in the early 1970s without securing mineral rights. In August 1990, the Kentucky Natural Resources and Environmental Protection Cabinet denied the University's request to protect the land by declaring it as a public park. At this time, the Cumberland Chapter of the Sierra Club, the Kentucky Resources Council, and the Kentucky Conservation Foundation to the Natural Resources and Environmental Protection Cabinet petitioned the state to declare the main tract of forest as lands unsuitable for mining. In February 1991, the state of Kentucky passed this declaration, although some sections within the main tract remained vulnerable. Further, Arch Minerals was allowed to mine part of the land on Robinson Forest for which it held mineral rights (Fig. 1). During that year, the University of Kentucky decided to lease out strip-mining rights for the five outlying tracts of Robinson Forest. The University of Kentucky administrators felt that leasing the mining rights would establish a financial foundation to help protect the main tract (Jaffee, 1991; Muller and Maehr, 2000).

In 1991, Equitable Resources Exploration of Kingport, Tennessee, planned to drill for natural gas on the main tract of the forest. Due to risk of public resentment and cost of drilling, these plans were dropped; however, Columbia Gas retained the rights to drill. Because the University of Kentucky still does not own rights to the natural gas under Robinson Forest, the risk of drilling remains (Jaffee, 1991).

In 1993, surface mining began on the outlying tracts and on the main tract. Surface mining on the main tract was completed in 1996 (Fig. 1). Mining of the outlying tracts of Robinson Forest continues to the present, with the potential for future mining.

During the summer of 1997, University of Kentucky president, Dr. Charles Wethington, declared that no additional mining would be permitted on Robinson Forest during the remainder of his tenure as president (which ended June 2001). Unfortunately, considerable discussion has surfaced (in 2001 and 2002) concerning the desire to mine Robinson Forest. Much of

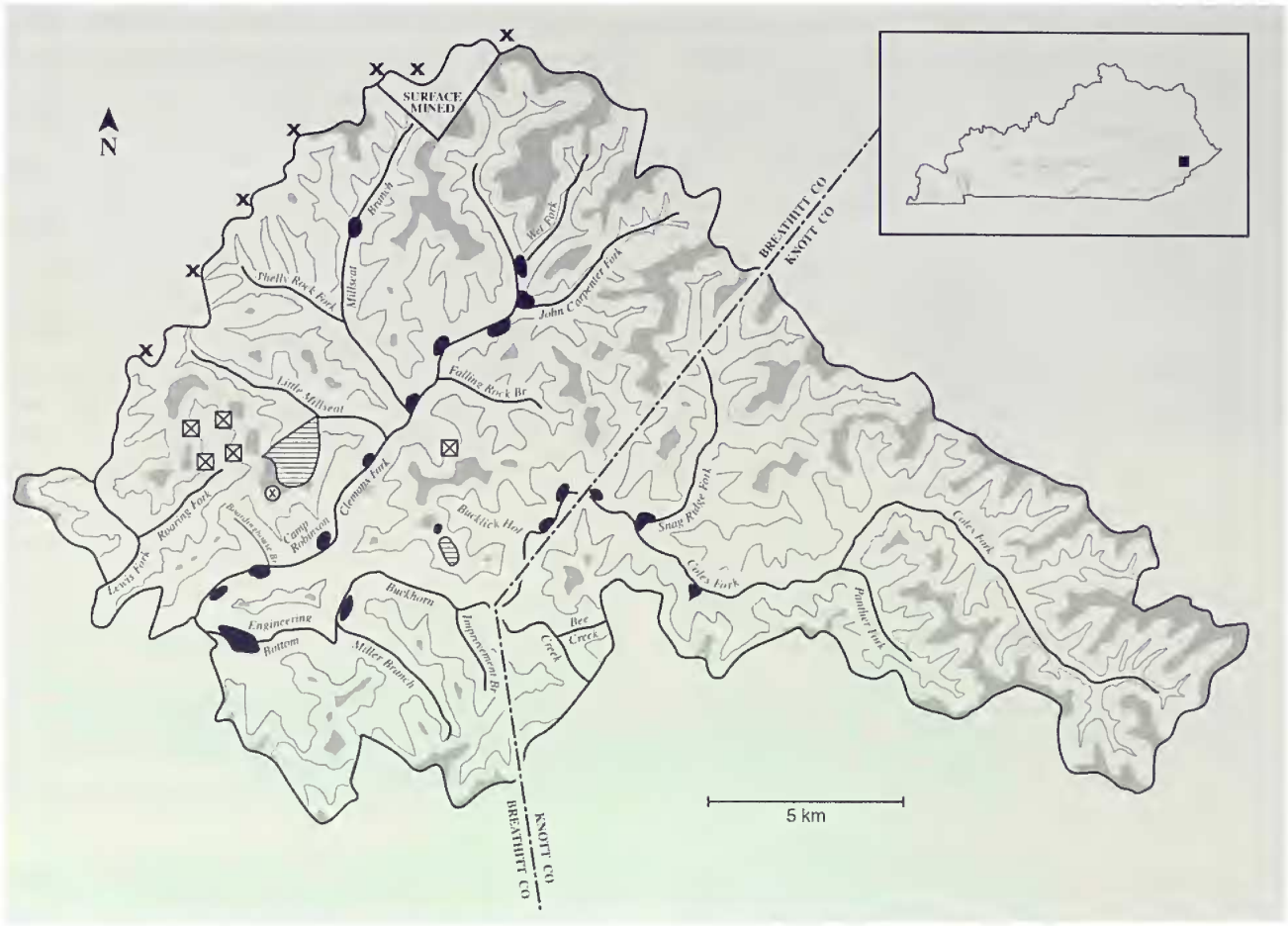

Figure 1. Map of the main tract of Robinson Forest in Breathitt and Knott Counties, Kentucky. The contour lines represent 366 m elevations, while the lightly shaded areas with contoured borders represent 425 m elevation. The black areas along the streams are wildlife clearings. The "X"s along the northwest boundary represent collection sites on the reclaimed surface mines. The five boxes that contain "X"s represent shelterwood timber cuts, while the two areas with diagonal lines are clear cuts made in the 1980s. The circle with the "X" in the center is the location of the fire tower.

this discussion is within the University of Kentucky. Robinson Forest's future as a protected wildlife refuge is not certain. This unique and isolated habitat island remains vulnerable to harmful decisions that could be made by future political forces.

Since Robinson Forest was established in 1923, fire has had a substantial impact on the ecology. In fact all fires that have burned in Robinson Forest during its history were the result of arson. In 1923, an abundance of illegally established homesteads existed throughout the forest. These residents were served eviction notices and the homes were torn down and burned. The evicted residents harbored animosity towards the university and responded by burning approximately 1800 ha from 1925 to 1935. After these evictions, fire suppression was a high priority. Firebreaks were dug along the forest boundary in 1930. Initially local labor was hired to fight fires, but this practice was discontinued because the locals were setting fires to generate work (Overstreet, 1984). Since 1923, approximately 80% of the forest has burned. No known records exist detailing the specific locations of the fires from 1923 to 1935, however, A. Marshall, Jr. and W. Marshall have provided first-hand records of fires since 1935 (Figure 2). The most severe fire season occurred in 1952 when approximately 2,500 ha covering the northern half of Robinson Forest burned (Fig. 2). Nine major fires have occurred since 1952 (Fig. 2). The section surrounding Lewis Fork has burned most frequently. In fact, fires occur in this section at least once a year (W. Marshall, pers.

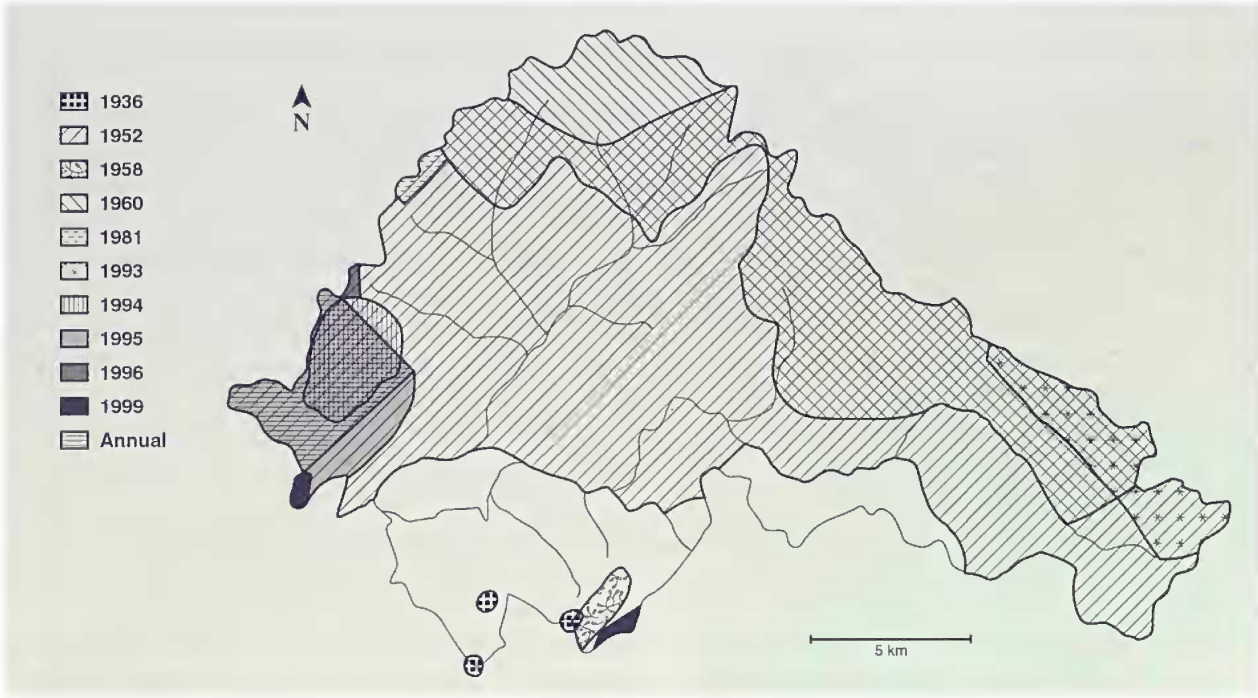

Figure 2. Location of fires that have occurred in Robinson Forest since 1936. White area has not been burned since 1936 and probably not since 1923. Too many fires are started within the "annual" area to accurately map their locations. The entirety of the annual area is not burned each year.

com.). This is the result of a public access road that follows Lewis Fork. Locals routinely set fires along this road with the most recent in November 2001. The oldest stand of forest is south of Buckhorn Creek, which has not been burned since 1936 (Fig. 2), and probably not since 1923.

History of Mammalogical Research in Robinson Forest

William Hamilton (1930) may have been the first person to collect mammals in Robinson Forest. Hamilton collected mammals in Breathitt County, with most of the collecting around the towns of Quicksand and Jackson approximately 20 km northwest of the forest. For five species accounts, Hamilton refers to Buckhorn Creek and Falling Rock Branch, both of which are in Robinson Forest. Wayne Davis (pers. com.) felt Hamilton probably collected in Robinson Forest, although Davis never specifically discussed trapping Robinson Forest during discussions with Hamilton. We have not examined any specimens from Robinson Forest collected by Hamilton, although any existing specimens may be at Cornell University or the American Museum of Natural History. Roger Barbour conducted the first confirmed collecting effort in June and July 1955. The second major collecting effort was part of a masters thesis project by Sjarief Hardjasasmita, a student of Barbour, during June and July 1960 and subsequent collecting trips during October 1960 and April 1961. Apparently, Barbour continued sporadic work at the Forest until 1966, although no specimens are available after 1961. Evidence for additional work on mammals does not exist until the early 1980s. In 1981, as part of his master's thesis, John Moriarty conducted a study to determine the effect of timber harvesting practices on vertebrates (Moriarty, 1982). As part of the study, Moriarty collected data on the importance of snags and natural tree cavities to Robinson Forest's mammals. This study involved the use of snap traps, pitfall traps, and the inspection of tree cavities. A total of 236 specimens were collected in pitfall traps and snap traps. Of these, only three voucher specimens are known to exist.

Wayne Davis and William McComb collected specimens from the forest and adjacent reclaimed surface mines in 1981 and 1983. Julianne Whitaker and Robert Frederick conducted a home range study of bobcats (*Lynx rufus*) in eastern Kentucky from 1986 to 1987 (Whitaker 1988, Whitaker et al., 1987). Some of the radio-collared animals where known to inhabit Robinson Forest. No other work on mammals was conducted until 1992 when Krupa and Haskins (1996) examined the ecological impact of new rodent species that invaded the forest. Studies on Rafinesque's big-eared bats (*Corynorhinus rafinesquii*) were conducted from 1993 to 1998 on feeding habits (Hurst, 1997; Hurst and Lacki, 1997) and on population size and habitat use (Hurst, 1997; Hurst and Lacki, 1999). Further, studies on red bats (*Lasiurus borealis*) were conducted during the same period. These studies included selection of day roosts (Hutchinson, 1998; Hutchinson and Lacki, 2000), foraging patterns (Hutchinson, 1998; Hutchinson and Lacki, 1999), and feeding behavior (Hutchinson and Lacki, 1998). An extensive survey of the abundance and distribution of the Allegheny woodrat (*Neotoma magister*) began in February 2000 and completed June 2001 (Krupa et al., in review). Currently, a study on the imfact of southern flying squirrel ecology is being conducted by Krupa.

METHODS

This study concentrated on the main tract of forest, and adjacent reclaimed surface mines on the northwest boundary. The seven outlying tracts were avoided because of disturbances such as active mining that began in 1993 and public hunting.

Field studies on the mammals of Robinson Forest began in March 1992 and ended in June 2001. Multiple approaches were used in gathering data. Much of the data resulted from collecting trips that specifically involved systematic trapping efforts in each of the four major habitats (low-elevation clearings, high-elevation clearing, mixed mesophytic forest, and reclaimed surface mines). Additionally, trapping was done with students during class field trips. During all trips, evidence of mammals was recorded. This included direct sightings, footprints, scat, burrows, and bones. Interviews with forest staff and biologists who conducted research at Robinson Forest provided invaluable information on mammals. We employed a rough method of quantifying sightings as number of individuals sighted per overnight trip (most trips lasted from 36 to 48 hours).

For small rodents and insectivorous mammals, Sherman live traps were used most extensively. To a limited extent, pitfall traps, victor rat traps, and museum specials were used. For woodrats, we set small Tomahawk live-traps (size No. 102 = 40 cm x 13 cm x 13 cm) and medium Tomahawk live-traps (No. 203 = 60 cm x 16 cm x 16 cm). Traps were baited with either an oatmeal-bird seed-peanut butter mix or with chopped apples, pears, grapes, and carrots. For raccoons (*Procyon lotor*), feral cats (*Felis catus*), and striped skunks (*Mephitis mephitis*), we used large Tomahawk live traps (No. 108 = 80 cm x 26 cm x 30 cm). These were baited with either canned cat food or canned sardines. For spotted skunks (*Spilogale putorius*) and weasels (*Mustela* sp.), we used wooden cubby traps (see Gilsvik, 1976 for trap design) and baited with droppings and urine from *Microtus pennsylvanicus* and *Peromyscus leucopus* or commercially prepared gland scent baits. Two types of cubby traps were used. The first was a 30 cm x 15 cm x 15 cm wooden box with a hinged top and a 5-cm hole on one end; a victor rat trap was attached to the floor with a 4 cm x 4 cm nylon treadle. The second type of cubby trap was 40 cm x 20 cm x 20 cm with a 7 cm hole at one end; a No. 1 Conibear trap was set upright inside. In addition, small Tomahawk traps were set in rocky outcrops and baited with fruit, peanut butter, and oatmeal. For moles, Victor Mole Traps and Victor Out O' Sight Mole Traps were set over active mole runs.

Two distinct approaches were employed for trapping southern flying squirrels (*Glaucomys volans*). Initially, victor rat traps were nailed to trees and baited with an oatmeal and peanut butter mix. In August 1999, twelve wooden platforms were attached to trees in the Engineering Bottom (Fig. 1). Half of these had 30 cm x 15 cm x 15 cm wooden boxes, filled with

sunflower seeds placed on top of the platforms for 5 weeks. These were then replaced with small Tomahawk live traps. In January 2001, 52 wooden platforms were attached to trees in the Engineering Bottom and on slopes adjacent to Camp Robinson. These were in five distinct tree communities. Wooden feed boxes (20 cm x 20 cm x 20 cm, with 5 cm diameter opening) were attached below half the platforms and filled with whole corn kernels, sunflower seeds, and balls of peanut butter and oatmeal. These were rebaited in early March. At the end of March and early May, small Tomahawk traps were placed on top of each platform and baited with peanut butter bait ball.

Bats were collected with mist nests placed at the entrance to the only known cave in Robinson Forest (hereafter referred to as the forest cave), over streams, over a pond, over water-filled road ruts, across jeep trails, and at the edge of clearings. Four species of bats were radio-tracked by attaching small (< 0.6 g in mass) transmitters to the dorsal surface (for additional details on methods see Hurst, 1997; Hutchinson, 1998). Bats were tracked at night using TRX 1000s telemetry receivers to determine foraging patterns and habitat use and located by day with receivers to identify day roost preferences. Food habits of Rafinesque's big-eared bats (*Corynorhinus rafinesquii*) were determined from examination of fecal pellets and identification of moth wings collected off of the floor of the forest cave used as a summer maternity roost and winter hibernaculum. Further, seasonal population size of Rafinesque's big-eared bats inside the cave was estimated using night vision equipment in summer and by periodic hibernaculum counts in winter.

Limited collecting occurred on reclaimed surface mines adjacent to the northwest boundary of Robinson Forest in the four habitat types typical of reclaimed sites.

On four nights from April 1993 to April 1994, 130 small Sherman live traps were placed in excavated hairy-tailed mole runs. After the trap was set, we placed a 45 cm x 45 cm piece of plywood over the excavation that was held down with a brick. The plywood prevented any small mammals from entering from the surface, thus all specimens trapped were in the mole runs. Specimens of dominant or characteristic plant species were collected from all clearings and from all trap sites on reclaimed surface mines. We qualitatively determined which plant species were characteristic of a location by visually assessing which species were most abundant. Specimens from each site were pressed and later keyed out to species.

Collections located at the University Kentucky School of Biological Sciences and the Department of Forestry were carefully examined for any Robinson Forest specimens that may have been collected over an 80-year period. Many of the specimens collected by Roger Barbour in Robinson Forest have museum tags with "Noble" as the location. This is a small cluster of houses at the western boundary of the forest that are shown as the town of Noble on some maps.

Most mammals collected during this study were released; however, voucher specimens were prepared as needed and trap fatalities were kept as well. All specimens examined for this study are housed at the University of Kentucky School of Biological Sciences (Appendix I). Final deposition of these specimens will be in the University of Kansas Natural History Museum. Finally, master's theses, dissertations, other unpublished literature, and published literature were examined for information on the mammalogy of the forest.

DESCRIPTION OF HABITATS

With respect to mammal ecology, the main tract of Robinson Forest and adjacent reclaimed surface mines are comprised of four major habitats. These include low-elevation clearings, high-elevation clearings, mixed-mesophytic forest, and reclaimed surface mines. An outline of major habitats and their subdivisions is shown in Table 1.

Low-elevation clearings: Two major watersheds are drained by Clemons Fork and Coles Fork creeks, both of which flow into Buckhorn Creek. Approximately 26 clearings ranging in area from 0.1 to 3.0 ha occur along the three streams (Fig. 1). Low-elevation clearings are either larger wildlife clearings or smaller mowed clearings between roads and streams (some of the later are not shown in Fig. 1). Most of these clearings are adjacent to streams and range in elevation from 250 to 300 m. Plant communities of these clearings vary greatly but can be categorized as grass-dominated (Figure 3; Appendix II) or herb-dominated (Figure 4; Appendix II). Eleven grass species were abundant in grass-dominated sites, typically with three to five grass species abundant at any one site. Grass-dominated sites lacked exposed earth characteristic of herb-dominated sites. Asters were mostly lacking at grass-dominated sites (Appendix II), while only two grass species were found at herb-dominated sites (Appendix II).

High-elevation clearing: Periodically over the years, ridge tops were clear cut for various dendro-

Table 1. Habitats in the University of Kentucky's Robinson Forest.

I. Low-elevation clearings
   A. Grass-dominated
   B. Herb-dominated
II. High-elevation clearings
III. Mixed-mesophytic forest
   A. Low-elevation mesic forest
      1. Basswood dominated
      2. Hemlock dominated
      3. Beech dominated
      4. Yellow-poplar dominated
   B. Mid-elevation transitional forest
      1. White oak dominated
      2. Oak-hickory dominated
      3. Black oak-chestmut oak dominated
   C. High-elevation xeric forest
      1. Scarlet oak-pine dominated
      2. Chestnut oak dominated
IV. Reclaimed surface mines
   A. Fescue-dominated slopes
   B. Xeric habitat dominated by legumes and autumn olive
   C. Xeric habitat dominated by grass, asters, and legumes
   D. Hydric habitat dominated by cattail, rushes, sedges

Figure 3. Grass-dominated, low-elevation wildlife clearing adjacent to Clemons Fork.

Figure 4. Herb-dominated, low-elevation wildlife clearing at the confluence of Snag Ridge Fork and Coles Fork.

logical studies. Typically, grasses are planted to prevent erosion along with various tree saplings (Appendix II). A series of successional plant communities occur until the area becomes forested. A 2-ha clearing was present during the study. It was cleared in 1989 and was three years old at the beginning of our study. It was located on a ridge top overlooking Bucklick Hollow and Coles Fork (Fig. 1). The elevation ranged from 320 to 430 m. This clearing was isolated from the nearest low-elevation clearings by 6 km of forest. For the first six years, a dense stand of broom-sedge (*Andropogon virginicus*) dominated the site. Bramble and 1-m tall tree saplings were dispersed through the grass (Appendix II). Of the saplings, Virginia pine (*Pinus virginiana*) and white pine (*P. strobus*) were planted, while others occurred naturally. By 2001, 4-m tall trees dominated the site and little grass remained.

Mixed-mesophytic forest: Robinson Forest is near the center of the mixed mesophytic forest region (Braun, 1950). This is the predominant habitat of Robinson Forest, with approximately 55 species of native and six exotic tree species present (Figure 5; Overstreet, 1984; 1989). Since completion of logging in 1923, Robinson Forest continues to approach the composition of a mature hardwood forest, despite selected timber harvest. Fire continues to influence the amount of mature forest. With respect to mammalian ecology, this mixed-mesophytic forest can be divided into three broad habitats: 1) the low-elevation mesic habitat; 2) mid-elevation transitional habitat; and 3) high-elevation xeric habitat.

Low-elevation mesic forest occurs at elevations ranging from 260 m to 320 m. This is the typical habitat along streams (Figures 6 and 7). Yellow-poplar (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), eastern hemlock (*Tsuga canadensis*), and rosebay rhododendron (*Rhododendron maximum*) dominate this habitat (Appendix II). Other characteristic species are listed in Appendix II. Damp soil, deep leaf litter, ferns, and moss-covered logs are characteristic. Overstreet (1989) subdivided this habitat into four forest community groups that occur at specific elevations. Starting with the lowest elevation, these include: 1) the streamside species group dominated by American basswood (*Tilia americana*) and rosebay rhododendron. This is primarily along Buckhorn Creek; 2) the hemlock species group dominated by eastern hemlock; 3) the beech species group dominated by American beech; and 4) the mesophytic species group dominated by yellow-poplar.

Figure 5. East-facing view of the main tract of Robinson Forest showing mixed-mesophytic forest. A high wall and associated surface mining activity appears in the background of the upper, left-hand. This is the surface mined area above Millseat Branch as shown in Figure 1.

The mid-elevation transitional forest occurs at elevations ranging from 325 m to 375 m. This habitat is typical of the steep slopes of Robinson Forest and is dominated by multiple species of oaks and hickories (Figure 8, Appendix II). Overstreet (1989) subdivided this habitat into three forest community groups. Starting from the lowest elevation, these include: 1) the white oak species group dominated by white oak (*Quercus alba*); 2) the mixed oak-hickory species group dominated by a variety of oaks and hickories such as black oak (*Q. velutina*), pignut hickory (*Carya glabra*), and mockernut hickory (*C. tomentosa*); and 3) the transitional species group mostly dominated by black oak and chestnut oak (*Q. prinus*). Cooler and wetter north-facing slopes occasionally have stands of rosebay rhododendron, while warmer and drier south-facing slopes often have stands of blueberries (*Vaccinium* sp.). Blueberries are especially abundant where recent fire has occurred. Rock outcrops and colluvial blocks (large rocks that have broken away from capstones and outcrops that are slowly moving down the slopes) are scattered throughout the mid-elevation forest (Figure 9).

High-elevation xeric forest habitat occurs at elevations from 380 m to 410 m and includes ridge tops. Scarlet oak (*Quercus coccinea*), chestnut oak, pitch pine (*Pinus rigida*), Virginia pine, and shortleaf pine (*P. echinata*) are characteristic of this habitat (Figure 10, Appendix II). Overstreet (1989) suggested that this habitat can be subdivided into two distinct forest community groups based on elevation: 1) the scarlet oak-pine group dominated by scarlet oak and three species of pine; and 2) the chestnut oak species group dominated by chestnut oak. All of the capstone formations occur on ridge tops of high-elevation forest (Figure 11). High elevation rock outcrops also occur in this habitat. Occasionally, the cool, north-facing sides of large capstones will have stands of rosebay rhododendron and eastern hemlock. Blueberries are most abundant in this habitat, especially where recent fire has occurred. Many of the pine trees were attacked by southern pine beetles (*Dendroctonus frontalis*) in 2000 and died in the spring of 2001.

Reclaimed surface mines: Reclaimed surface mines surround the main tract of Robinson Forest.

Figure 6. Low-elevation mesic forest habitat along Clemons Fork showing moss covered logs. Eastern hemlock and American beech are in the background.

Figure 7. Low-elevation mesic forest habitat along Clemons Fork. Rosebay rhododendron is seen growing on the north-facing slope (right side of stream).

Figure 8. Mid-elevation, transitional habitat above Coles Fork showing deciduous hardwood tree species of American beech oaks, maples, hickories, and yellow-poplar.

Figure 9. Rock outcrop (background) and colluvial blocks (foreground) characteristic of mid-elevation, transitional forest habitat above 370m.

Figure 10. Oak-pine tree community above Camp Robinson characteristic of high-elevation xeric habitat. The shortleaf pine and Virginia pine in the foreground were killed by southern pine beetles (*Dendroctonus frontalis*) in the spring of 2001.

Five mammal collection sites were established in four of the many habitats along the northwest border (Fig. 1). Reclaimed sites ranged from 1 to 20 years of age since last mined. The sampled habitats range from hydric to xeric conditions and from sparsely to densely vegetated. Many species of nitrogen-fixing legumes were planted over most of the reclaimed area. The soils of all collection sites lacked organic-rich topsoil. Instead soils are compact and comprised of shale, sandstone and coal ranging in size from course gravel to fist-sized rocks (Figure 13*b*).

The habitats include: 1) fescue-dominated slopes adjacent to high walls; 2) sparsely vegetated xeric habitat dominated by legumes; 3) sparsely vegetated xeric habitat dominated by asters, grasses, and legumes; and 4) hydric low-lying habitat dominated by wetland vegetation.

In areas where mining was completed, steep slopes occur adjacent to mining high walls that mark the boundary of Robinson Forest (Fig. 12). These high walls are 20 to 40-m tall cliffs that are formed during mining. Surface rubble was bulldozed up against the high walls producing steep slopes intended to reduce the distance of the vertical drop (Fig. 12). Fescue (*Festuca arundinacea*) is planted to stabilize the slope and reduce erosion. Relatively few plant species occur on these slopes with most of the vegetation comprised of fescue, crowned vetch (*Coronilla varia*), and black locust (*Robinia pseudoacacia*; Appendix II).

Xeric habitat dominated by legumes and autumn olive is the most extensive habitat on reclaimed surface mines (Figure 13*a*). Exposed soils are extensive and little grass grows. This habitat is dominated by several species of Asian legumes (*Lespedeza* spp.), the exotic autumn olive (*Elaeagnus umbellata*) and black locust (Appendix II). Exposed soil comprised of compact rock rubble is common (Fig. 13*b*).

Xeric habitat dominated by grasses, asters, and legumes is densely vegetated (Figure 14, Appendix II). Up to four species of bunch grass were abundant in these areas and black locust was often present.

Hydric low-lying habitat ranges from areas with temporary water (Figure 15) with stands of cattails (*Typha latifolia*) and rushes (*Juncus* sp.) to ponds surrounded by cattails, bulrushes (*Scirpus cyperinus*), and rushes (Appendix II). The well-drained mesic soils surrounding these areas have dense stands of grasses comprised of up to four species (Appendix II).

Figure 11. Capstone formations above Roaring Fork (see Figure 1) made of sandstone characteristic of ridge tops.

Figure 12. Slope with young black locust and tall fescue characteristic of reclaimed surface mines on the north-west boundary of Robinson Forest above Lewis Fork.

A

B

Figures 13 A and B. Xeric habitat: A) dominated by black locust, autumn olive, and dense stands of exotic lesbedeza on reclaimed surface mines; and B) a section of this habitat with soil comprised of compact rock rubble.

Figure 14. Xeric habitat dominated by a dense stand of grass on reclaimed surface mines on the northern boundary of Robinson Forest.

RESULTS

Table 2 summarizes the mammals collected in pitfall traps during this study, while Table 3 summarizes the bats caught in mist nets. Tables 4 and 5 summarize all specimens trapped during the study and associated trap success. Tables 6 and 7 summarize unpublished data from Moriarty (1982). Of the 235 specimens captured during Moriarty's study, only three museum specimens are known to exist. Thus, it was not possible to confirm the identification of specimens. A total of 147 museum specimens representing 19 species collected before 1992 were located and examined (Appendix I). A total of 151 specimens representing 28 species were collected after 1992 (Appendix I).

Since Barbour and Hardjasasmita (1966) published in their original checklist for the mammals of Robinson Forest, evidence for 16 additional species exists. These include: pygmy shrew (*Sorex hoyi*), silver-haired bat (*Lasionycteris noctivagans*), hoary bat (*Lasiurus cinereus*), little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), Appalachian cottontail (*Sylvilagus obscurus*), woodchuck (*Marmota monax*), eastern harvest mouse (*Reithrodontomys humulis*), prairie vole (*Microtus ochrogaster*), meadow vole (*M. pennsylvanicus*), woodland jumping mouse (*Napaeozapus insignis*), black bear (*Ursus americanus*), coyote (*Canis latrans*), mink (*Mustela vison*), eastern spotted skunk (*Spilogale putorius*), and elk (*Cervus elaphus*). Two species listed by Barbour and Hardjasasmita (1966) appear to be extinct in the forest; the include the golden mouse (*Ochrotomys nuttalli*) and muskrat (*Ondatra zibethicus*).

Each species of mammal known to occur at Robinson Forest is discussed below. With two exceptions, we followed the common and scientific names in Jones et al. (1997). We retain "Allegheny woodrat" as the common name for *Neotoma magister* rather than "Appalachian woodrat" in Jones et al. (1997). Second we retain *Corynorhinus rafinesquii* for Rafinesque's big-eared bat rather than *Plecotus rafinesquii* in Jones et al. (1997). Subspecies are from Hall (1981).

Figure 15. Hydric habitat dominated by sedges, rushes, and cattailes in low-lying areas of reclaimed surface mines. High wall in background is the northern boundary of Robinson Forest.

Table 2. Results of collecting mammals with pitfall traps in Robinson Forest from March 1992 to April 2000. Capture rates indicate individuals caught per 100 trap nights based on 1545 trap nights. Numbers in parenthesis indicate total individuals captured.

Species	Capture rate
Blarina brevicauda (6)	0.39
Sorex fumeus (11)	0.72
Sorex hoyi (1)	0.06
Parascalops breweri (1)	0.06
Microtus pennsylvanicus (2)	0.13
Peromyscus leucopus (4)	0.26
Reithrodontomys humulis (1)	0.06

Table 3. Results of collecting bats with mistnets in Robinson Forest from April 1992 to May 2001. Capture rates indicate individuals caught per 100 trap nights based on 105 net nights. Numbers in parenthesis indicate total individuals captured.

Species	Capture rate
Corynorhinus rafinesquii (6)	5.71
Eptesicus fuscus (9)	8.57
Lasionycteris noctivagans (10)	9.52
Lasiurus borealis (29)	27.62
Lasiurus cinereus (1)	0.95
Myotis lucifugus (0)	0.00
Myotis septentrionalis (37)	35.24
Pipistrellus subflavus (7)	6.67

Table 4. Results of trapping mammals in Robinson Forest from March 1992 to June 2001.

Species	Total number of Individuals captured	Trap Nights	Per 100 Trap nights
Blarina brevicauda [a b c]			
Clearings	36	2366	1.52
Forest	4	1778	0.22
Reclaimed mines	3	309	0.97
Parascalops breweri [e]			
Clearings	4	65	6.15
Glaucomys volans [d]			
Forest	90	223	40.36
Tamias striatus [a b c d]			
Forest	3	1603	0.18
Microtus pennsylvanicus [a b c]			
Clearings	78	2201	3.54
Forest	2	1778	0.11
Reclaimed mines	13	309	4.21
Microtus pinetorum [a b c]			
Clearings	23	2201	1.04
Forest	4	1422	0.28
Mus musculus [a b c]			
Clearings	1	2201	0.05
Neotoma magister [d]			
Forest	21	273	7.69
Peromyscus leucopus [a b c]			
Clearings	55	2366	2.32
Forest	101	1778	5.68
Reclaimed mines	30	309	9.71
Reithrodontomys humulis [a b c]			
Clearings	10	2201	0.45
Synaptomys cooperi [a b c]			
Clearings	5	1755	0.28
Reclaimed mines	3	309	0.97
Napaeozapus insignis [a b]			
Forest	1	902	0.11
Felis catus [f]			
Clearing	2	38	5.26
Mephitis mephitis [f]			
Clearings	5	38	13.20
Spilogale putorius [d g]			
Forest	1	273	0.36
Procyon lotor [f]			
Clearings	4	38	10.53

[a] *Sherman live traps,* [b] *museum specials,* [c] *rat traps,* [d] *small tomahawk,* [e] *medium tomahawk traps,* [f] *large tomahawk traps,* [g] *cubby traps,* [e] *mole traps*

Table 5. Results of below-ground trapping in hairy-tailed mole runs along the edge of clearings and streams. Values represent individuals per hundred trap nights. Numbers in parenthesis represent the total number of individuals caught. A total of 10 museum specials were set below ground in April 1993, while 40 small Sherman live traps were set below ground on each of the following dates: September 1993, December 1993, and April 1994.

Traps plugged by	April 1993	September 1993	December 1993	April 1994
Parascalops breweri	0	5 (2)	0	10 (4)
Blarina brevicauda	10 (1)	0	0	2.5 (1)
Microtus pennsylvanicus	10 (1)	0	0	0
Microtus pinetorum	10 (1)	0	27.5 (11)	0

Table 6. Results of collecting mammals with pitfall traps in Robinson Forest from Moriarty's (1982) unpublished study. Capture rates indicate individuals caught per 100 trap nights based on 9000 trap nights. Numbers in parenthesis indicate total individuals captured.

Species	Capture rate
Blarina brevicauda (12)	0.13
Sorex fumeus (102)	1.13
Sorex hoyi[1] (9)	0.10
Microtus ochrogaster[1] (1)	0.01
Microtus pinetorum (2)	0.03
Peromyscus leucopus (15)	0.17
Napaeozapus insignis (1)	0.01

[1]Specimens do not exist and identification was not confirmed

Table 7. Results of collecting mammals with snap traps in Robinson Forest from Moriarty's (1982) unpublished study. Capture rates indicate individuals caught per 100 trap nights based on 1800 trap nights. Numbers in parenthesis indicate total individuals captured.

Species	Capture rate
Blarina brevicauda (5)	0.28
Sorex fumeus[1] (6)	0.33
Peromyscus leucopus (1)	0.06
Napaeozapus insignis (81)	4.5

Didelphidae
Didelphis virginiana virginiana Kerr, 1792
Virginia opossum

Barbour and Hardjasasmita (1966) reported the Virginia opossum to be rare in Robinson Forest since 1955. Moriarty (1982) observed a single specimen in Falling Rock Hollow, although no specific date was given. The only specimen available is a mandible found on 20 June 1960 on the Boardinghouse Brook trail that exits Camp Robinson (Fig. 1). The Virginia opossum remains uncommon in Robinson Forest. We never observed it in the forest, despite this species being a common road kill along the 24-km stretch of highway leading to the forest. We have failed to trap specimens despite having set large Tomahawk traps in Camp Robinson, in the Engineering Bottom, and along Clemons Fork for a total of 39 trap nights. Gardner (1999) reported that this species prefers deciduous forest with permanent water. Preferred den sites include caves, hollow logs, burrows dug by woodchucks and striped skunks, and human-made structures. Barbour and Davis (1974) reported that the Virginia opossum prefers forest edge. The rarity of this species may be due to several factors such as lack of edge habitat and den sites. Moreover, hollow logs and human-made structures are sparse, and predators such as bobcats and, more recently, coyotes are common.

Soricidae
Blarina brevicauda kirtlandi
Bole and Moulthrop, 1942
Northern short-tailed shrew

Barbour and Hardjasasmita (1966) reported the northern short-tailed shrew to be common in all habitats. Twelve specimens were collected during their study from June to October 1960 and three in April 1961. Moriarty (1982) reported this shrew to be common in forest habitat but less common than *Sorex fumeus* (Tables 6 and 7). We found this shrew to be one of the more common mammals and the most abundant shrew in Robinson Forest. This species occurs on reclaimed surface mines, in low-elevation clearings, and in all forest habitat (Krupa and Haskins, 1996; Table 5). We found this species least common in the forest habitat. Short-tailed shrews are most often found in clearings with meadow voles. This association may be a combination of both species preferring the same habitat, and because short-tailed shrews prey on *Microtus pennsylvanicus* (Getz et al., 1992). Like many of the small mammals of Robinson Forest, the short-tailed shrew has seasonal periods when it is difficult to trap. Currently, we do not know if the abundance of this species varies between the three sub-habitats of the mixed-mesophytic forest.

Sorex fumeus fumeus Miller, 1895
Smoky shrew

Barbour and Hardjasasmita (1966) trapped a single specimen on 28 April, 1961, although we were unable to locate this specimen. Moriarty (1982) reportedly collected 102 of his 108 specimens from pitfall traps in forest habitat although no specimens exist (Table 6). We found this shrew exclusively in forest habitat and at the edge of the Engineering Bottom. We did not collect any specimens with snap traps or Sherman live traps. Eleven of the 12 specimens collected during this study were in pitfalls. Five specimens were collected in pitfalls from October 1993 to February 1994. Four were caught during the evening of 6 February, 1994. All of these specimens were in pitfalls placed next to rotting, moss-covered logs. Our 12th specimen was found on 18 February 2000. This was a freshly dead specimen lying on a horizontally angled sapling, 1.5 m off the ground in high-elevation forest habitat. Even though specimens have been collected from the three forest habitats, we have collected too few to determine a preferred habitat.

Sorex hoyi thompsoni (Baird, 1858)
Pygmy shrew

Barbour and Hardjasasmita (1966) did not list the pygmy shrew for Robinson Forest. This is the rarest shrew in the forest. Moriarty (1982) reported collecting nine specimens in pitfall traps. Seven of these were caught in the Buck Lick watershed and two from the Falling Rock watershed. Three specimens were collected in spring, two in summer, and four in fall. Only one of these specimens is known to exist. It is a skull and skeleton collected on 14 March, 1981 in a pitfall trap from the "south slope." Caldwell and Bryan (1982) published this as a county record. We collected a single specimen from a pitfall trap on 28 March, 1993; the pitfall was next to a rotting, moss-covered log in low-elevation, mesic forest habitat. It was 2 m from the Engineering Bottom on the south side of Buckhorn Creek.

Talpidae

Parascalops breweri (Bachman, 1842)
Hairy-tailed mole

Barbour and Hardjasasmita (1966) collected a single specimen on 23 June, 1955. We have found mounds of this species to be rare in Robinson Forest. In contrast, tunnels are abundant in many areas of the forest. Some of these are shallow causing the surface of the soil to be pushed up. Tunnels typically are 3 to 6 cm under ground. Evidence of these cannot be seen on the surface. Tunnels are abundant in the narrow band of brushy habitat along Clemons Fork and Buckhorn Creek and especially along the two streams when mowed roadsides and clearings are present. On three separate occasions from September 1993 to April 1994, we were able to locate 40 separate tunnels in this edge habitat within 2 hours of effort. Evidence suggested this species was common; nonetheless, we found hairy-tailed moles difficult to collect. Using mole traps, we collected 3 specimens in September and October 1992 and another in March 1994 (Table 4). A fifth specimen was collected alive in a pitfall trap on 6 February, 1994 (Table 2). From April 1993 to April 1994, we excavated 120 mole runs and placed small Sherman live traps in them to determine if other mammals used the runs. Hairy-tail moles packed 6 of these traps with soil (Table 5). Although we have found most tunnels in clearings and along streams, hairy-tailed moles probably occur everywhere in Robinson Forest. On 12 May, 2000, we found a dead specimen on a gravel road 100 m from the northern boundary of Robinson Forest on a reclaimed mine. It appeared this individual was dispersing from high-elevation, xeric forest habitat. One of the specimens we collected was in a mowed area beside a jeep trail running along a ridge top. We also found runs in the high elevation clearing.

We found the most effective way to trap hairy-tailed moles was to locate tunnels close to the surface where the soil is pushed up. We then used four fingers to push down the top of the tunnel causing a section of the tunnel to collapse. These collapsed sections were flagged and checked later. If the soil was pushed up and the tunnel reopened, then it was probable that a mole could be trapped at that active site.

Vespertilionidae
Corynorhinus rafinesquii rafinesquii
(Lesson, 1818)
Rafinesque's big-eared bat

Rafinesque's big-eared bats were first reported in Camp Robinson by Barbour (1957). He collected five adults on 14 June, 1955 and seven juveniles on 22 June 1995 in "an attic". We have examined six of these specimens. Barbour and Hardjasasmita (1966) reported the existence of a large maternity colony of 100 individuals in the attic over Camp Robinson's unfinished cafeteria (presumably the same attic). Forest personnel began blocking off access to the attic in the mid-1950s. This led to a decline in the size of the colony. By 1966 only six adults remained. No subsequent evidence of Rafinesque's big-eared bats exists for Camp Robinson and, in all likelihood, this species was eradicated from the camp by the late 1960s.

In late December 1992 a visitor to the forest reported sighting bats with "very large ears" in the forest cave. A subsequent visit to the cave on 21 January, 1993 resulted in the discovery of 14 Rafinesque's big-eared bats roosting on the side of a wall inside a large sandstone fissure formed by slope failure. Subsequent visits to the cave on 10 February, 1995, 4 January, 1997, and 14 March, 1998 produced totals of 21, 17, and 49 Rafinesque's big-eared bats, respectively (Hurst and Lacki, 1999). Summer emergence counts have shown the colony to be at its largest in late July with a maximum of 118 bats observed on 29 July, 1995 (Hurst and Lacki, 1999).

The entrance to the cave was netted on 14 June, 1995 and five Rafinesque's big-eared bats, three lactating females and two scrotal males, were captured and fitted with transmitters (Hurst and Lacki, 1999). In flight, bats remained close to the roost exhibiting foraging areas ranging from 61.6 to 225.3 ha (Hurst and Lacki, 1999). Rafinesque's big-eared bats showed a preference for oak and oak-hickory forest habitats situated along upper slopes and ridge tops (Hurst and Lacki, 1999). One male chose to relocate his roost approximately 5 m high, inside the cavity of a large fire-scarred American beech.

Collection and identification of culled moth wings from inside the cave demonstrated that Rafinesque's big-eared bats prey heavily on underwing moths (Noctuidae: *Catocala* spp.; Hurst, 1997). Examination of fecal pellets showed Lepidopera to be the primary component (90.9 % volume) of the diet of this bat in Robinson Forest, with Coleoptera, Homoptera, Diptera, Hemiptera, Hymenoptera, and Trichoptera taken to a much smaller degree (Hurst and Lacki, 1997).

Whether the population in the cave is somehow connected with the original colony located in Camp Robinson remains unclear. The guano pile below the maternity roost is only 15 cm deep. This suggests the colony is fairly recent (e.g., the last 25 years). It is possible this is the colony that formerly occupied Camp Robinson. The cave supports a healthy breeding population and the number of bats remains fairly stable from year to year (Hurst and Lacki, 1999).

We have invested considerable effort trying to locate other colonies in Robinson Forest. On 4 May, 2001, we observed a *C. rafinesquii* in the crevices of a rock outcrop immediately west of Camp Robinson. This outcrop is comprised of deep horizontal and vertical crevices. Cool air can be felt leaving the crevices. This suggests the crevices are deep and complex. It is possible that another colony could exist at this site, however, it is more likely that this is a summer roost for a single male. Other than at the entrance of the cave, only one individual was netted at any other location. This was an adult male that was netted over a water-filled road rut on a ridge top above Bucklick Hollow on 12 August, 2000 (Fig. 1). It is probable that this individual was part of the cave colony 5 km to the west. The rarity with which we have netted this species over open water suggests that it tends to fly high above the ground and, thus, remains fairly elusive.

Eptesicus fuscus fuscus
(Palisot de Beauvois, 1796)
Big brown bat

Barbour and Hardjasasmita (1966) suggested that big brown bats in Robinson Forest are either transient individuals or summering males. They did not find any indication that breeding colonies existed in the for-

est. They reported shooting their only specimen over Camp Robinson on 27 April, 1961. We have not located this specimen, but have found three other museum specimens collected by Barbour in June 1955. On 11 April, 1992, an adult male and adult female were netted in Camp Robinson. The net was set up in a roofed breezeway connecting the cafeteria to an adjacent building. Both bats were caught at 2100 hr and were probably roosting in the attic over the cafeteria. We have netted this species over streams such as Clemons Fork and Buckhorn Creek. An adult female with two volant young was observed roosting under the eve of a cabin in Camp Robinson in August 1997. These bats regularly returned to the same eve each morning after nightly feeding bouts. They did not appear to be bothered by the presence of people in camp. Another adult female was netted over Clemons Fork on 25 September, 1998. This bat was an older individual with noticeable wear on the upper incisors. Our data indicate that big brown bats are more common in Robinson Forest than suggested by Barbour and Hardjasasmita (1966) and that no large maternity colony was found, the species occasionally does rear pups on the forest.

Lasionycteris noctivagans (Le Conte, 1831) Silver-haired bat

Barbour and Hardjasasmita (1966) did not list the silver-haired bat for Robinson Forest. Barbour and Davis (1974) reported this species as state wide, but rare. They suggested that silver-haired bats are either winter residents or migrants to be found in Kentucky in October and April. Meade (1992) reported silver-haired bats as an uncommon species in Kentucky that is associated with rock crevices and the mouths of caves. Most of the Kentucky records are from the Daniel Boone National Forest in eastern Kentucky, where such habitat is abundant (J. MacGregor, USFS, unpubl. data). Silver-haired bats were first netted in Robinson Forest on 12 October, 1991, under overhanging branches on Clemons Fork in close proximity to Camp Robinson. Four adults (three females and one male) were netted. The following spring, a silver-haired bat was netted over Clemons Fork in Camp Robinson on 11 April, 1992. Two more specimens were collected over Clemons Fork on 7 April, 2000 and three additional specimens at the same location on 3-4 May, 2001. The last four bats were netted over an atypical section of stream that was open and free of overhanging vegetation. Most of the lower stretch of Clemons Fork has a fairly dense growth of branches from shrubs and trees over the water. These captures suggest that silver-haired bats regularly use Robinson Forest as a stopover site during migration.

Lasiurus borealis borealis (Müller, 1776) Eastern red bat

Barbour and Hardjasasmita (1966) reported red bats to be common throughout the forest. We have examined three specimens Barbour collected in June 1955 and a fourth that Hardjasasmita collected on 27 June, 1960. This species is observed flying over streams, clearings, and in Camp Robinson at sunset. This is the second most common bat in Robinson Forest (Table 3) and the most commonly netted bat over streams. We have netted this species over high-elevation road ruts, but it typically is outnumbered by *Myotis septentrionalis*. Red bats can be seen flying on warm nights during any season. We have watched them flying as late as 27 October, 1997 and as early as 16 February, 1994. On the later date, the bat was flying over a clearing adjacent to Clemons Fork at 1745 hr when the temperature was 7° C. That same evening, another specimen was observed flying over Camp Robinson at 1800 hr. On 27 March, 1998, a red bat was observed at 1400 hr flying over a clearing along Clemons Fork. This was in full sunlight with the temperatures at 30° C. On 4 March, 2000, an individual was observed along a ridgetop, hanging from a mountain laurel *(Kalmia latifolia)* bush 1.2 m above the ground.

Radio-tracking studies in Robinson Forest have shown red bats to have foraging areas ranging in size from 113 ha to 850 ha (Hutchinson, 1998; Hutchinson and Lacki, 1999). Red bats increased the size of their foraging area as summer progressed. Riparian corridors were used extensively (Hutchinson, 1998; Hutchinson and Lacki, 1999). This species day roosted in the outer foliage of dominant and co-dominant hardwood canopy trees at the top of ridges (Hutchinson, 1998; Hutchinson and Lacki, 2000), and almost exclusively within the interior forest (Hutchinson, 1998; Hutchinson and Lacki, 2000). Adult females with young

were observed in Robinson Forest indicating that suitable maternity habitat exists (Hutchinson, 1998). Red bats were observed feeding on moths in flight and gleaning crickets off of the ground around street lights in Camp Robinson (Hutchinson and Lacki, 1998).

Lasiurus cinereus cinereus (Palisot de Beauvois, 1796) Hoary bat

Barbour and Hardjasasmita (1966) did not report the hoary bat in Robinson Forest. Only one individual was collected during this study; it is the only known specimen from Robinson Forest. On 3 May, 2001, an individual was netted at midnight over Clemons Fork downstream from Camp Robinson. This site is one of the only stretches of stream that lacks overhanging vegetation and is where most silver-haired bats were netted. The specimen was an adult female carrying two embryos; each was 5 mm in length (crown to rump). Barbour and Davis (1969) reported hoary bats as being rare or rarely caught in the eastern United States. This is true for Kentucky in general and Robinson Forest in particular. This is the only specimen we netted anywhere in Kentucky.

Myotis lucifugus lucifugus (Le Conte, 1831) Little brown myotis

Hamilton (1930) did report the little brown myotis as common in Breathitt County. Hamilton collected specimens from a church in Jackson, 20 km west of the forest. Apparently, he did not collect specimens from Robinson Forest. Barbour and Hardjasasmita (1966) did not report the little brown myotis as being present in the Forest. Only one specimen was collected in Robinson Forest. On 1 June, 2001, a male was found in a wooden bluebird nest box in Camp Robinson. The box was 1.8 m high on a wooden post that supports the roof over the camp gas tanks. Of the eight species of bats known from the forest, this is the only one we were unable to mist net. Barbour and Davis (1974) considered the little brown myotis to be common and local in the summer, especially in eastern Kentucky where it can form large nursery colonies. Further, Barbour and Davis (1974) considered this species to be a common winter resident in large caves. Robinson Forest lacks buildings with hot attics that can support nursery colonies, and the only cave in Robinson Forest is small and not typical of what we expect as a winter roost. Nonetheless, it is rather surprising that we have found so little evidence of this species in Robinson Forest.

Myotis septentrionalis (Trouessart, 1897) Northern myotis

Barbour and Hardjasasmita (1966) did not report the northern myotis present in Robinson Forest. Meade (1992) cited the Fish and Wildlife Information System as reporting the first records from Breathitt County. The first known specimen from Robinson Forest was a male captured on 13 October, 1993 along a jeep tail just above Clemons Fork. Subsequent netting at various sites in the forest from 31 May to 17 August, 1995 resulted in the capture of 22 northern myotis, including adult males, pregnant and lactating females, and juveniles of both sexes (Table 3). A total of 37 individuals were netted since 1993 (Table 3). The northern myotis apparently is the most common bat in Robinson Forest. Virtually all specimens were netted over water-filled road ruts on ridge tops. Only rarely have they been netted at low elevations or over streams. We have netted as many as 10 specimens in a single evening. Most of the existing road ruts have not been netted. In all likelihood, doing so would reveal that this species is more common than Table 3 indicates. During winter surveys of the forest cave, this species was found in small numbers and associated with *Pipistrellus subflavus* and *Corynorhinus rafinesquii*.

Adult males with epididymes visible were recorded on 8 and 9 August, 1995. A male northern myotis, captured on 25 September, 1998 near the fire tower, was radio-tagged and relocated on 26 September. This bat was found roosting high up in a 25-cm diameter Cucumber tree (*Magnolia acuminata*) in close proximity to the original capture site. Our data indicated that at least one maternity colony of northern bats was located on the forest. Our mistnetting suggests additional colonies may occur in areas where numerous water-filled road ruts exist.

Pipistrellus subflavus subflavus (F. Cuvier, 1832) Eastern pipistrelle

Barbour and Hardjasasmita (1966) reported eastern pipistrelle as the most common bat in Robinson Forest. We have examined 8 specimens that were collected from 21 June to 4 July, 1960. In comparison, we have netted a total of 7 specimens over a ten-year period (Table 3). The most recent specimen was netted over Clemons Fork in Camp Robinson on 20 July, 2000. This species is difficult to collect in Robinson Forest. It is occasionally found in the forest cave during winter surveys. We have netted eastern pipistrelles over streams, over road ruts and in high elevation clearings. Our netting efforts suggest eastern pipistrelles are not as common as Barbour suggested. Then again this might merely reflect differences in collecting methods; Barbour used a shotgun not mistnets. Three pregnant females were captured in a clearing just below the fire tower on 13 June, 1995, suggesting that Robinson Forest does provide suitable maternity habitat for eastern pipistrelles.

Leporidae

Sylvilagus floridanus mearnsii (J. A. Allen, 1894) Eastern cottontail

Barbour and Hardjasasmita (1966) reported eastern cottontails as common in clearings near Camp Robinson but absent from within the forest. We examined a study skin without a skull that was collected by Barbour on 28 June, 1955. We found eastern cottontails to be uncommon in Robinson Forest. This species occasionally was observed feeding on mowed grass in Camp Robinson and more frequently in the Engineering Bottom. On 3 May, 2001, a lactating female was collected in the road along Clemons Fork, 3 km upstream from Camp Robinson. This is the only confirmed eastern cottontail collected in forest habitat away from grass clearings. We have two other sightings of rabbits in forest habitat (12 March and 3 May, 2001), but these may have been Appalachian cottontails (see account below). During 31 over-night trips from 1992 to 1998, we recorded three sightings of eastern cottontails in Robinson Forest and all were from Camp Robinson. From January 1999 to May 2001, rabbit droppings were abundant in the Engineering Bottom (which is the largest wildlife clearing in the forest), but none were found in Camp Robinson. On April 1999, we found a 50-cm burrow that appeared to be used by a rabbit. This was on a steep slope about 10 m above the Engineering Bottom. Rabbit tracks were visible in the dry soil around the hole. On 17 June, 2000, five eastern cottontails were observed at 0800 hr in the Engineering Bottom. Three were adults and two subadults. All five were feeding on grass 1 to 3 m from the dense vegetation that grows between the road and the clearing. The Robinson Forest staff has commented that the population in the Engineering Bottom fluctuates greatly from year to year and was unusually high in 2000. Our observations agree with this. In the summer of 2001, we could not find any evidence of eastern cottontails in the Engineering Bottom. Eastern cottontails are abundant on the reclaimed surface mines along the northwest boundary of Robinson Forest (see figures 12 through 14 for habitat).

Sylvilagus obscurus Chapman, Cramer, Dippenaar, Robinson, 1992 Appalachian cottontail

Sylvilagus obscurus recently was described as a separate species from *S. transitionalis* (New England cottontail; Chapman et al., 1992). Barbour and Davis (1974) listed a single known specimen from Big Black Mountain on the Virginia border of southeastern Kentucky. Recently, the Appalachian cottontail was found to be more widely distributed in eastern Kentucky than previously known. A recent survey by Sole (1997) examined 550 cottontail heads collected from hunters from 1991 to 1995. Of these, 73 skulls were identified as Appalachian cottontails from 20 counties in eastern Kentucky. Four collection sites were from Breathitt and Knott counties near Robinson Forest. In Kentucky, this species is confined to the eastern coalfields (Sole, 1997). It is thought to prefer high-elevation hardwood forests with conifers, mountain laurel, and blueberries (Chapman, 1999). Sole's (1997) data suggest that Appalachian cottontails are not restricted to high elevations and could be found in a wide range of habitats. In Kentucky, they appear to prefer early successional forests with an ericaceous understory of mountain laurel, blueberries, and green brier (*Smilax* sp.). Barbour and Hardjasasmita (1966) did not include this species as occurring in Robinson For-

est. They specifically commented that rabbits were never observed in the forest. Further, Moriarty (1982) did not observe any rabbits during his study. Currently, we have not collected a specimen of this species in the forest. However, we have collected rabbit droppings and sighted two rabbits at high-elevations deep in the forest away from clearings. It is likely that Appalachian cottontails are in the forest.

In February 2000, we found an abundance of rabbit droppings around a large capstone along a ridge top northwest of Camp Robinson. Additional droppings were found near a rock outcrop on the north slopes above Shelly Rock Fork (Fig. 1). These droppings are lighter in color and larger than any of the eastern cottontail droppings collected in Camp Robinson or the Engineering Bottom. On 16 March, 2001, a rabbit was observed on the road above Little Millseat (325 m) and below where the February 2000 droppings were found. This rabbit had shorter, rounder ears than what is typical for eastern cottontails. This site is at the edge of an area that was clear cut in the 1980's and is now early successional forest habitat (Fig. 1). A second rabbit was observed on 6 May, 2001 on a south-facing slope above Clemons Fork, 0.5 km west of Camp Robinson. The elevation was 350 m, and the rabbit was in a group of large colluvial rocks that resembled a talus cone formation. Steve Thomas (KDFWR, pers. com.) live trapped an Appalachian cottontail four times along a cliff line in Menifee County northwest of Robinson Forest. This habitat was early successional forest that looked similar to the location where we found the droppings in Robinson Forest. In both locations, these rabbits are associated with large, complex rock formations with an abundance of crevices and numerous large disconnected sandstone blocks. It may be that rocks are an important habitat requirement for this species. Nonetheless, we can not confirm this association until specimens are collected. It is possible that the droppings and sightings are of eastern cottontails that are moving into the deep forest habitat. The recent collection of an eastern cottontail along Clemons Fork (albeit at low elevations of 260 m; see *S. floridanus* account above) illustrates the need to collect specimens to determine if two species do occur in Robinson Forest and assess their distribution.

Castoridae
Castor canadensis carolinensis
Rhoads, 1898
American beaver

In 1947, the Kentucky State Department of Fish and Wildlife Resources stocked American beavers in Robinson Forest (Overstreet, 1984). This species quickly disappeared and is the only unsuccessful stocking effort in the forest (Noble and Davenport, 1961). Barbour and Hardjasasmita (1966) did not list this species. In February 2001, a young individual was observed on the bank of Buckhorn Creek at the mouth of Long Branch 2 km west of the main tract of Robinson Forest (D. Marshall, pers. com.). It is not surprising or unexpected that individuals occasionally stray up Buckhorn Creek. Beavers are common in the Kentucky River system 60 km west of Robinson Forest. Buckhorn Creek feeds into the south fork of the Kentucky River via Troublesome Creek. We have not seen any evidence of beaver in Robinson Forest. Suitable habitat does not exist and all evidence suggests this species has not existed in the forest since 1947.

Sciuridae
Glaucomys volans volans
(Linnaeus, 1758)
Southern flying squirrel

Barbour and Hardjasasmita (1966) reported southern flying squirrels to be common in Robinson Forest but rarely seen. Four specimens were collected during their study; the one existing specimen was collected on 8 July, 1955. These authors reported sign of this species, such as cuttings and arboreal nests, as common. Moriarty (1982) reported that this species was in both Bucklick and Falling Rock watersheds during tree cavity checks; however; he provided no quantitative data on abundance. From 1992 to 1998, we had no success in collecting southern flying squirrels when rat traps baited with peanut butter nailed to the sides of trees. We had much greater success placing wooden boxes filled with seed on platforms six weeks before trapping. On the day we trapped, the seed boxes were removed and replaced with Tomahawk live traps. This improved trap success to 1% (3

southern flying squirrels in 12 traps). On 10 February, 2001, wooden feed boxes were attached to 26 of the 52 wooden platforms in the Engineering Bottom and the slopes west of Camp Robinson. These were in four tree communities dominated by: 1) American beech and eastern hemlock at low elevations; 2) American beech and white oak at mid-elevations; 3) black oak, chestnut oak, white oak, mockernut hickory, and pignut hickory at mid- to high elevations; and 4) chestnut oak and scarlet oak at high elevations. Fifty-two #102 tomahawk live traps were placed on these platforms on three nights (30 March, 31 March, 3 May, 2001). We trapped 21, 24, and 34 flying squirrels, respectively, for a 51% trap success in the four tree communities combined. At high elevations, southern flying squirrels were living in dead trees and snags that were common on the ridge tops. This was the only location we trapped that lacked American beech. In all other communities, southern flying squirrels had a strong preference for American beech trees. Many of these trees are hollow and have fire scars that produce triangular-shaped openings at the base of the tree. Many of the flying squirrels we released glided to the bases of these trees and escaped into the openings. Most of these trees had visible evidence of flying squirrels. Midden piles were conspicuous below these openings and were comprised of American beech nut hulls and eaten hickory nuts. Southern flying squirrels are one of the most abundant rodents in Robinson Forest (Table 4).

Marmota monax monax (Linnaeus, 1758) Woodchuck

Barbour and Hardjasasmita (1966) did not include woodchucks in their original checklist. Moriarty (1982) recorded a single sighting for this species in the Falling Rock watershed. We observed one specimen in 1992. This was a large adult with a burrow at the base of a sycamore tree on the bank of Clemons Fork in Camp Robinson. Forest staff report that woodchucks usually occur in Camp Robinson. Occasionally woodchucks become camp pests and have to be removed. In May 2000, three woodchucks were living near the superintendent's house in Camp Robinson. Woodchucks prefer grassy roadsides at the edge of forests (Barbour and Davis, 1974; Svendsen, 1999). We spent considerable effort looking for evidence of this species along the edges of clearings, with no success. Edge habitat is rare in Robinson Forest, thus the paucity of woodchucks in Robinson Forest is not surprising.

Sciurus carolinensis carolinensis (Gmelin, 1788) Eastern gray squirrel

Barbour and Hardjasasmita (1966) stated that eastern gray squirrels are found throughout the forest. They collected a single specimen, which we have examined. Moriarty (1982) reported gray squirrels as being common in both Bucklick and Falling Rock watersheds during his study, although quantitative data were not provided. The only quantitative information available is from 30 October to 1 November, 1980, when Moriarty recorded two sightings per watershed during this three-day period. Forest staff frequently commented that this species' population density fluctuates in Robinson Forest. Further, they commented that the population was low during the last 20 years. Gray squirrels were considered most common along Clemons Fork in the 1950s and 1960s (A. Marshall, Jr., pers. com.).

Eastern gray squirrels are secretive in Robinson Forest. Typically these squirrels are seen briefly as they dash across a road. We rarely hear them vocalizing while we drive or walk the roads. The only times we heard eastern gray squirrels occurred while we were sitting quietly on rock outcrops at sunset. On 15 January, 2001 we sat on a ridge top above Little Millseat from 1600 hr until dark. During this time, 7 gray squirrels were visible within 100 m of us. They foraged on the ground, actively moved in the trees, and vocalized. Others could be heard in the distance. We have observed shifts in the frequency of gray squirrel sightings during this study. For example, a total of 13 eastern gray squirrels were observed on 45 overnight trips from March 1992 to November 2000 (0.29 squirrels per trip). In contrast, we recorded 68 sightings during 7 trips from January to May 2000 (9.7 squirrels per trip). We suspect the explanation (as with eastern chipmunks) might be connected to mast production of American beech. After five poor years (1995 to 1999), the American beech mast in 2000 was excellent. Forest staff commented that it was one of the best masts they could recall. This could have stimu-

lated fall reproduction of eastern gray squirrels. All seven of the individuals we observed on January 15 were small and likely from fall litters.

Tamias striatus striatus (Linnaeus, 1758)
Eastern chipmunk

Barbour and Hardjasasmita (1966) reported eastern chipmunks to be abundant throughout the forest. They collected 7 specimens from June 1960 to April 1961. Moriarty (1982) reported chipmunks as being abundant in the Bucklick and Falling Rock watersheds during two three-day observation periods in spring and summer of 1981. We have trapped only three individuals during the last 10 years (Table 5). This low number is more indicative of trapping technique than abundance. We have never left trap lines out in forest habitat during the day when this species is active. Eastern chipmunks are secretive and usually observed for brief moments. Observations suggest fluctuations in population densities. During our first 45 overnight trips (1992 to 2000), we observed 18 individuals (0.40 chipmunks per trip). During 7 over night trips in 2001, we observed 24 eastern chipmunks (3.4 chipmunks per trip). As discussed above for eastern gray squirrels, the increase in sightings might indicate the population increased due to the American beech nut mast of 2000.

Muridae

Microtus ochrogaster ohioensis (Bole and Moulthrop, 1942)
Prairie vole

Barbour and Hardjasasmita (1966) did not list the prairie vole as present in Robinson Forest. Moriarty (1982) reported trapping one specimen in the Bucklick watershed on March 1981. This specimen is not known to exist and identification was never confirmed. Although most likely a meadow vole, this specimen could have been a prairie vole. Wayne Davis collected a single specimen from Camp Robinson on 20 April, 1980. We have examined the study skin, although the skull was lost. The study skin exhibits the characteristic "salt and pepper" coloration of the dorsal pelage, and the belly is distinctly buff colored. The dry open habitat preferred by this species is lacking in Robinson Forest. Thus, it is surprising that any specimens were trapped in the forest. Bill McComb (pers. com.) reported isolated colonies in suitable habitat on reclaimed surface mines just outside the northern boundary of Robinson Forest. We have seven skeletons collected by McComb from this area in 1983. These were collected from dense stands of broom sedge. It is highly unlikely that this species was ever established in Robinson Forest.

Microtus pennsylvanicus pennsylvanicus (Ord, 1815)
Meadow vole

Barbour and Hardjasasmita (1966) did not list the meadow vole as present in Robinson Forest. The first known specimen was collected in 1980 (Wayne Davis, pers. com.). This specimen is not known to exist. The unidentified specimen collected by Moriarty (1982) and discussed in the account above may have been a meadow vole. By 1983, Bill McComb (pers. com.) reported collecting meadow voles on reclaimed surface mines and in clearings around Camp Robinson. By 1992, meadow voles were established and abundant in clearings (Krupa and Haskins, 1996). It was hypothesized that the apparent invasion of this vole was the combined result of climatic changes, construction of new roads with fescue-dominated roadsides, and reclaimed surface mines planted with a variety of grasses. The latter two factors created habitat corridors for this species' dispersal into Robinson Forest. Meadow voles have become the dominant mammal in grass-dominated clearings in Robinson Forest (Table 4), while they are absent from forest habitat.

This species is very difficult to trap from June to October (Krupa and Haskins, 1996, present data and discussion on this phenomenon). Further, fresh sign of activity is rare during these seasons. In contrast, meadow voles are easily trapped from December to May with abundant sign of activity (droppings and grass clippings along actively maintained runs). To date, we have failed to collect data that might explain this phenomenon. The leading hypothesis at present is that the population drops during the warm months when snake predation (by copperheads, *Agkistrodon contortrix*; black rat snakes, *Elaphe obsoleta*; and black racers, *Coluber constrictor*) is at its highest. The population then rebounds when snakes are inactive. We have found an abundance of these snakes near clearing during the summer.

Microtus pinetorum carbonarius (Handley, 1952) Pine vole

Barbour and Hardjasasmita (1966) reported pine voles to be uncommon in the forest habitat but more abundant in overgrown fields along Buckhorn Creek. We have examined 21 specimens collected from June to October 1960, of which 16 were caught during a 2-day period in July. All specimens appear to be from clearings. Moriarty (1982) caught no pine voles in snap traps in 1,800 trap nights and only three specimens in 9,000 pitfall nights (Table 6). These data support Barbour and Hardjasamita's (1966) observation that pine voles are not common in forest habitat. Of the 27 specimens we trapped, 24 were collected in clearings. The remaining three were collected in forest habitat. This is the species most commonly seen running on the surface of sparsely vegetated clearings in daylight. Further, we commonly found pine voles (approximately 40 individuals) under logs and boards in clearings. Sheets of plywood left out in clearings are especially preferred by this species. Frequently these boards will have a nest made of grass and a network of tunnels that have two to three exits to the surface as well as an equal number that go deeper into the soil. On 27 March, 1998, a piece of plywood 1 x 1.5 m had four adult pine voles underneath, while a similar sized piece of plywood 10 m away had two adults. The pine vole is the most commonly caught mammal in mole tunnels (Table 5), indicating that this is one of the most fossorial rodents in Robinson Forest. On 9 April, 2000 at 1000 hr, we observed a sharp-shinned hawk (*Accipiter striatus*) capture a pine vole on a ridge top above Bucklick Hollow (Figure 1). Pine voles might be more common in forest habitat than trapping data suggest. Fossorial habits could prevent it from coming into contact with traps set on the surface. The large number of pine voles trapped in mole tunnels (abundant throughout the forest) suggests this. Further, an abundance of runs can be found under logs and rocks throughout the forest. These closely resemble the pine vole runs we find under plywood in clearings.

Mus musculus Linnaeus, 1758 House mouse

Barbour and Hardjasasmita (1966) reported the house mouse as rare and collected three specimens along Buckhorn Creek. We were unable locate these. We collected one specimen in October 1996 in a fescue-dominated clearing along Clemons Fork downstream from Camp Robinson. Further, we have trapped no house mice in the Camp Robinson buildings (only white-footed mice) in ten years suggesting this non-native species remains rare in Robinson Forest.

Neotoma magister Baird, 1858 Allegheny woodrat

Hamilton (1930) reported collecting two "blue rats" (= Allegheny woodrats) along Fallen Rock Branch. This may be the tributary of Clemons Fork (Fig. 1); however, we have not found suitable rock formations there. Barbour and Hardjasasmita (1966) reported the Allegheny woodrat to be uncommon in Robinson Forest. They collected one specimen during their study, which we have examined. They felt that the low abundance was due to scarcity of rock outcrops. Krupa et al. (in review) examined and trapped 152 rock structures (capstones, rock outcrops, large colluvial rocks, and talus cones). Of these, 57 had evidence of *N. magister* (droppings, feeding stations, middens), while only twelve yielded woodrats. This could suggest that the species is in decline; however, we do not know the historical abundant. Midden piles can last for decades. Some still have American chestnut (*Castanea dentata*) hulls, which woodrats gathered at least 70 years ago. It is possible that the forest has always had a small population of woodrats and that most middens were unoccupied at any one time. In Robinson Forest, Allegheny woodrats prefer capstone structures and rock outcrops located in high-elevation, xeric forest habitat. Preferred sites have deep, dry crevices. The presence of old midden piles and past trapping effort shows that this woodrat once occurred in the mid-level, xeric forest habitat. Prime habitat for Allegheny woodrats occurs to the north and west of Robinson Forest, where extensive cliff lines and massive capstones exist. In contrast, Robinson Forest is marginal habitat because these structures are rare. Allegheny woodrats do occur in the forest cave. We trapped two individuals in March 2000, and evidence suggested that even more individuals were present in the cave.

Ochrotomys nuttalli aureolus (Audubon and Bachman, 1841) Golden mouse

Barbour and Hardjasasmita (1966) collected a single specimen of golden mouse in a brush-covered hillside along Buckhorn Creek. We do not know the specific location. We were unable to locate this specimen or find any record of it in Barbour's personal catalog. The authors commented that this rodent is rare due to a lack of habitat such as brushy areas. The only suitable habitat for this mouse occurs along the edge of the Engineering Bottom where several small, dense stands of the exotic Japanese honeysuckle (*Lonicera japonica*) vine and blackberry (*Rubus* sp.) occur. We have trapped repeatedly in this habitat with no success. It is doubtful that this species exists in Robinson Forest, or that it was ever established. Golden mice were abundant 90 km south of Robinson Forest in Cumberland Gap National Historical Park, where Barbour et al. (1979) trapped seven specimens in 42 traps (17% trap success) on 7 January, 1978. The mice were in thickets of *L. japonica*. Barbour et al. (1979) felt this trap success was unusual and probably due to a peak in the population cycle. If so, some golden mice might disperse north to Robinson Forest during periods when population densities were high to the south.

Ondatra zibethicus zibethicus (Linnaeus, 1766) Muskrat

Barbour and Hardjasasmita (1966) occasionally observed muskrat in the lower reaches of Buckhorn Creek. They also reported cuttings and footprints in Clemons Fork adjacent to Camp Robinson. In August 1998, we set Tomahawk traps along Buckhorn Creek over the course of two nights (22 trap nights). We baited the traps with fruit and commercial scent bait. No muskrats were caught. We have never observed evidence of muskrats anywhere in Robinson Forest. Further, the habitat along Buckhorn Creek is not suitable. It appears that more suitable habitat occurred in the 1960s. During that time the road along Clemons Fork was public access and open to the active surface mines and used by coal trucks. Due to extensive use, erosion occurred along the road. Clemons Fork became filled with sediment. Will Marshall (pers. com.) reported that during the 1960s numerous 2-m deep "swimming holes" existed along the lower stretches of Clemons Fork and Buckhorn Creek caused by sedimentation dams. This would have provided more suitable habitat for muskrats. The Clemons Fork road was closed to the public in 1970, and the sediment was washed away with seasonal flooding (W. Marshall, pers. com). From staff recollection, no evidence of muskrats was observed since. It appears that even in the 1960s, muskrats were never well established in Robinson Forest.

Peromyscus leucopus noveboracensis (Fischer, 1829) White-footed mouse

Barbour and Hardjasasmita (1966) reported the white-footed mouse to be the most common mammal of Robinson Forest. We examined 6 study skins collected in June 1955 and 45 study skins collected from June to October 1960. Moriarty (1982) found this mouse to be the second most abundant species. Moriarty (1982) caught this species most often in snap traps (87% of all captures; Table 7), and it was the second most common mammal caught in pitfall traps (Table 6). We found white-footed mice in all habitats, but they were twice as abundant in forest habitat when compared to clearings (Table 4). We consistently experienced low trap success (ranging from 0% to 10%) along streams in the eastern hemlock-American beech community. On 31 March, 2001, we compared trap success in four tree communities: 1) dominated by American beech and eastern hemlock at low elevations; 2) dominated by American beech and white oak at mid-elevations; 3) dominated by black oak, chestnut oak, white oak, mockernut hickory, and pignut hickory at mid- to high elevations; and 4) dominated by chestnut oak and scarlet oak at high elevations. Trap success was 2.5%, 15%, 30%, and 30%, respectively. White-footed mice are the least fossorial of the rodents as we have never trapped any in mole tunnels (Table 5).

Reithrodontomys humulis humulis (Audubon and Bachman, 1841) Eastern harvest mouse

Barbour and Hardjasamita (1966) did not list this mammal in Robinson Forest. The eastern harvest mouse is one of the most difficult rodents to trap in Kentucky. Mumford and Whitaker (1982) reported this species as trap shy and most likely caught from December to February. We collected eight specimens from January and February 1994 in three clearings along Clemons Fork. Repeated efforts to trap additional specimens from these clearings were unsuccessful from August 1994 to October 1998. A specimen was trapped in a fescue-dominated roadside clearing in November 1998. Two specimens were collected from the Engineering Bottom in April 1999, and another specimen was collected from a pitfall trap in a wildlife clearing in April 2000. Ten of these specimens were collected in short, dense stands of fescue approximately 15 cm tall. The other two were collected in a clearing dominated by native warm season grasses such as broomsedge, redtop panic grass (*Panicum rigidulum*), and switch grass (*P. virgatum*). All specimens were trapped in active *Microtus pennsylvanicus* runs.

Synaptomys cooperi stonei Rhoads, 1893 Southern bog lemming

Before meadow voles appeared in Robinson Forest, southern bog lemmings were the most abundant vole in clearings. Barbour and Hardjasasmita (1966) collected 20 specimens in Camp Robinson during a 10-week period during June and July 1960. We have examined all of these. Barbour and Hardjasasmita collected four times more specimens in ten weeks than we collected over a ten-year period. Since the invasion of meadow voles, southern bog lemmings have become extremely rare (Krupa and Haskins, 1996). On average 351 trap nights are required to capture a single southern bog lemming (Table 4). Meadow voles are considered competitively superior to southern bog lemmings (Linzey, 1984). Consequently, the two species are usually not found together. Currently, meadow voles tend to be most abundant in clearings with dense growths of grass, while southern bog lemmings tend to occur in clearings with marginal habitat dominated by a sparse growth of herbaceous species (Krupa and Haskins, 1996). Meadow voles apperantly out-competed and eliminated southern bog lemmings from most clearings.

Zapodidae

Napaeozapus insignis roanensis (Preble, 1899) Woodland jumping mouse

Barbour and Hardjasasmita (1966) did not list the woodland jumping mouse as present in Robinson Forest. We have two specimens (study skins without skulls) from Robinson Forest. The first specimen was collected by Wayne Davis on 21 May, 1980 along Field Branch at an elevation of 335 m (Fig. 1). Houtcooper (1982) published this record. The second existing specimen was collected by William McComb in the Engineering Bottom on 22 May, 1981. Moriarty (1982) reported collecting one specimen in a snap trap in Bucklick Hollow during his fall (30 October to 1 November 1981) sampling (Table 7) and a second in a pitfall trap in Falling Rock Hollow during his summer (24-26 June 1981) sampling (Table 6). These specimens are not known to exist. We obtained the most recent specimen near the location of Moriarty's study. The mouse was captured in a stand of planted white pine (*Pinus strobus*) along Clemons Fork and the confluence of Little Millseat Branch on 13 October, 1991 (Fig. 1). The specimen was a lactating female. This stand of pines was thinned in 1984. The midstory and understory were open, suggesting limited complexity in habitat structure. Our current data suggest that woodland jumping mice are rare, if not extinct, in Robinson Forest. Little can be said about the biology of this species in the forest. All specimens were caught in forest habitat at a range of elevations. Robinson Forest appears to have an abundance of ideal habitat for this species according to Barbour and Davis (1974). North-facing hollows have streams with dense stands of vegetation where this species should be found. Most of the specimens were collected at locations in close proximity to one another such as Falling Rock Branch, Field Branch, Bucklick Hollow, and along Clemons Fork below Little Millseat Branch (Fig. 1). Repeated collecting efforts at these locations from 1995 to 2000 were unsuccessful.

Canidae
***Canis latrans thamnos* Jackson, 1949**
Coyote

Coyotes arrived in Kentucky in the early 1970s. Barbour and Davis (1974) were aware of a single specimen from central Kentucky. They suspected it was a captive individual that escaped. Coyotes have now spread throughout Kentucky. Apparently, coyotes first appeared in the vicinity of Robinson Forest in 1991 (W. Marshall, pers. com.), although, it has been suggested coyotes arrived earlier (J. Cox, pers. com.). Coyotes have been reported as common on reclaimed surface mines all around the forest. Will Marshall (pers. com.) heard them call on the ridge tops above Clemons Fork in October 1999. Until 2000, we saw or heard little evidence of coyotes in Robinson Forest. During evenings of 4 and 12 August, 2000 and again on 15 January, 2001, we heard coyotes calling on reclaimed surface mines on the north and south boundaries of the forest. Coyotes were heard calling along Coles Fork on 15 January, 2001. We found more sign of coyote in the forest in 2000 than for the previous eight years combined. Scats and footprints have been found on jeep trails along Buckhorn Creek, Little Millseat Creek, and above Roaring Fork (Fig. 2). Scat were comprised of deer fur and bone. Five seats collected along Buckhorn Creek in March 2000 had an abundance of large deer bone chips from long bones and one complete phalange. We did not observe coyotes during the first 38 weekend trips of this study. On 19 May, 2000, a subadult coyote was observed running across a jeep trail on the northern boundary of the forest. On 9 July, an adult was seen nearby along John Carpenter Fork (Fig. 1). In 2000 and 2001, John Cox observed coyotes feeding on deer carcasses staked out beside the "Overstreet" house on the east slopes above the Engineering Bottom (Fig. 1). Cox trapped and radio-collared eight coyotes during October 2000 above Laurel Fork (a smaller tract of Robinson Forest 4 km west of the main tract), as well as a pup along Long Fork (3 km west of the main tract) in March 2001. The pup moved into the main tract of Robinson Forest and remained around Little Millseat (Fig. 1) up until May 2001. From our observations and Cox's research, it appears that coyotes prefer the open habitat of reclaimed surface mines with occasional movement into the forest. At this time, we do not know what, if any, impact coyotes may have as a new predator in Robinson Forest.

Urocyon cinereoargenteus cinereoargenteus
(Schreber, 1755)
Gray fox

Barbour and Hardjasasmita (1966) did not collect any specimens and noted that it was rare to observe gray fox. They did report that tracks of this fox were commonly found on logging roads throughout the forest. We found three skulls during this study from along Clemons Fork at Falling Rock Branch in July 2000, Camp Robinson in August 2001, and above Roaring Fork in December 2001. We have little quantitative data on this species. Nonetheless, this is one of the two major mammalian predators (the bobcat is the other) in Robinson Forest. Tracks and scats of the gray fox are abundant in the forest. On occasion we have had trap lines set in forest habitat disturbed by gray foxes. One trap line, set on 27 March, 1992 near the fire tower, was visited by a predator who set off 50% of the traps. Fur of the gray fox was attached to one of the dew-covered Sherman live traps. A similar situation occurred on 2 October, 1992. Sherman traps set in a high elevation wildlife clearing were disturbed (5 of 60 traps); and again, a strand of gray fox fur was attached to a dew-covered trap. Compared to raccoons, gray fox are far less destructive or disruptive when they discover trap lines. Over the years, gray foxes have become "pets" in Camp Robinson. In the late 1980's, a gray fox became quite tame and spent time at the house of then superintendent John Overstreet above the Engineering Bottom and in Camp Robinson. This fox would follow Overstreet as he drove from his house to the camp. During spring 2000, two gray fox visited Camp Robinson each night we were there. One was visibly smaller than the other (probably a subadult). These fox were bold and collected food scraps left out by students. Often the pair would come within 20 m of large groups of students sitting at the campfire. Typically the foxes would appear at dusk and remain in camp as late as 0100 hr. The foxes were observed and heard barking near camp every night that we stayed at Camp Robinson for nearly a year. These two individuals were last observed together in camp in November 2000. A single individual was in camp in May 2001. It was typical to hear barks and "cries" of gray foxes during every evening that we were in camp in 2001.

Felidae
***Felis catus* Linnaeus, 1758**
Feral cat

Feral cats occasionally occur in Robinson Forest, mostly in or near Camp Robinson. We have found bones in the Engineering Bottom. We have not found feral cats deep within the main tract away from camp, although there were reports of this being the case in the 1940s and 1950s (A. Marshall, Jr., pers. com). Feral cats do not tend to survive long in Camp. This is partially due to predation by raccoons. In 1998, a female cat became a camp resident and had a litter of five kittens that year. The young quickly disappeared; and by 1999, only one kitten survived to adulthood. Forest staff observed a raccoon killing the original adult female in 1998.

***Lynx rufus rufus* (Schreber, 1777)**
Bobcat

Barbour and Hardjasasmita's (1966) only record of this species was a set of footprints found in mud on a logging road in the summer of 1960. In the 1980s, Julianne Whitaker and Robert Frederick conducted a study on the home range of bobcats in eastern Kentucky. Ten bobcats were trapped north of Robinson Forest and fitted with radio-collars (Whitaker, 1988; Whitaker et al., 1987). Several of these bobcats moved through Robinson Forest with some individuals preferring to remain in the forest (Frederick, pers. com.). The home ranges of six males from this study averaged 59.4 km^2, while the home ranges for four females averaged 4.7 km^2. On 3 May, 1996, Greg Adkison observed a bobcat for approximately 10 min in Tom's Branch Hollow. The bobcat was seen walking down a steep slope of a northeast-facing hollow where it entered a first order stream and waded for several minutes. The only bobcat we observed was on 5 August, 2000. We had a brief glimpse as it ran across a road along Millseat Branch (Fig. 1). We found an abundance of footprints and scat. These signs were especially common near rock outcrops where Allegheny woodrat middens occur. Bobcats are in all likelihood a significant predator in Robinson Forest. This species benefits by and frequents the reclaimed surface mines and clearings where dense cottontail and vole populations provide an important food source. Frederick et al. (1989) reported that of the 83 scats collected, 60% contained the remains of *Microtus pennsylvanicus*.

Mephitidae
Mephitis mephitis nigra
(Peale and Palisot de Beauvois, 1796)
Striped skunk

Barbour and Hardjasasmita (1966) reported striped skunks as rarely encountered in Robinson Forest. They observed a skunk in camp in October 1960, and reported collecting a specimen along Clemons Fork downstream from Camp Robinson. We have not located this specimen. Striped skunks were common in Camp Robinson and in the dump upstream along Clemons Fork in the early 1990s. In 1992, the population of striped skunks around Camp Robinson became so large that a musk odor was constantly present in camp. At that time, ten skunks were destroyed (W. Marshall, pers. com.). From 1992 to 1995, it was common to observe striped skunks in camp after sunset. Striped skunks routinely wandered into camp during evenings during class trips. On several occasions skunks boldly wandered up to students as they sat around the campfire. From 1996 to June 2001, we did not observe or trap striped skunks in Camp Robinson. One was observed eating food scraps next to the superintendent's house in camp in May 2000. It appears that striped skunks were most abundant during a period when food scraps and other trash were deposited in a compost heap in camp as well as in the dump. The current practice is to secure trash in predator-resistant containers prior to being hauled out. This practice may be the primary factor that has reduced the abundance of striped skunks in Robinson Forest. With three exceptions, all sightings of stripped skunks were in Camp Robinson or at the dump upstream from camp. In March 2001, an adult was observed on a high-elevation road above the confluence of Coles Fork and Buckhorn Creek. The skunk rooted in the soil on the edge of the road for 30 minutes before moving up the slope and out of sight.

The variation in color pattern is notable. In Robinson Forest, the color ranges from: black fur with a large white blotch on top of the head and around the ears; to black fur with a single broad white band that

extends from the top of the head to midway on the back: to the typical pattern of black fur with two broad white bands that extend the length of the body and a tail that is a mix of black and white fur; to the dorsal half of the skunk is all white and the ventral half is black; to all white. Will Marshall reported that a pure white skunk was a common camp visitor from 1990 to 1992.

Spilogale putorius putorius (Linnaeus, 1758)
Eastern spotted skunk

Eastern spotted skunks are considered rare in Kentucky (Barbour and Davis, 1974) and are currently listed as a species of special concern (KSNPC, 1996). Barbour and Hardjasasmita (1966) nor Moriarty (1982) reported this species in Robinson Forest. Meade (1992) reported a specimen from Knott County (a portion of Robinson Forest lies in this county). Over a ten-year period, we have trapped extensively for this species. In 1992, we found footprints on a well-worn trail along a rock outcrop above Clemons Fork. We set five small conibear traps along the trail for 3 nights with no success. On 8 April, 2000, we caught an adult eastern spotted skunk on a south-facing slope above Snag Ridge Fork in the Knott County section of Robinson Forest (see Fig. 1). The skunk was caught beside an Allegheny woodrat midden located in a crevice of a rock outcrop at 300-m elevation. The small tomahawk was baited with carrots and apple slices. The specimen was photographed and released. This represents the only known specimen of eastern spotted skunk in Robinson Forest.

Mustelidae
Mustela vison vison Schreber, 1777
Mink

Hamilton (1930) reported tracks of mink along Buckhorn Creek. Neither Barbour and Hardjasasmita (1966) or Moriarty (1982) presented any information on mink in Robinson Forest. We found footprints of mink to be abundant along the sandy shoreline of Buckhorn Creek and occasionally on patches of sand along Coles Fork. At 1000 hr on 19 February, 1994, an adult mink was walking in the road along the upper stretches of Clemons Fork. It then waded into a stream with a depth of 20 cm and began to swim upstream for 5 m. When it saw us, the mink climbed to shore and ran upstream along the bank. During a biology class fish collecting trip to Buckhorn Creek on 8 April 1999, a mink was observed running up stream on the far bank from the students. In front of a group of 15 students, the mink entered an 8-cm diameter opening into a sycamore tree (*Platanus occidentalis*). The opening was partially below water level. The mink repeatedly looked out at us over a 30-minute period.

Procyonidae
Procyon lotor lotor (Linnaeus, 1758)
Raccoon

Hamilton (1930) reported raccoon tracks as common along Buckhorn Creek, while Barbour and Hardjasasmita (1966) reported raccoons as being scarce in Robinson Forest. Moriarty (1982) reported finding them in tree cavities on two occasions (one in Bucklick Hollow and the other in Falling Rock Hollow). This species is most prevalent around Camp Robinson, the dump upstream from camp along Clemons Fork, and in the Engineering Bottom. We commonly found footprints along most of the streams in the forest. We have seen little evidence of raccoons on slopes or ridge tops. Evidence of raccoons in Camp Robinson has fluctuated over the duration of this study. Efforts to make trash containers more raccoon proof and hauling food scraps out of the forest seem to have reduced the number of raccoons. Occasionally, troublesome individuals occur in Camp Robinson and have to be destroyed.

Ursidae
Ursus americanus americanus Pallas, 1780
Black bear

Black bears were largely extirpated from the state with occasional sightings along the Virginia and Tennessee borders (Barbour and Davis, 1974). Robinson Forest staff have not observed any black bears from 1935 to 2001. Nevertheless, sightings of this ursid in eastern Kentucky have become increasingly frequent during the 1990s. In October 1999, prints and scrapings of black bears were found in the Coles Fork drainage of Robinson Forest and again in February 2000 (J. Larkin, pers. com.). Motion sensitive cam-

eras were set out at this site in an unsuccessful effort to confirm the presence of a bear (J. Cox, pers. com.). Three black bears were released in Robinson Forest in the 1990s. All three individuals were nuisance animals from eastern Kentucky; each of these individuals had been reported as causing trouble on three occasions. In Kentucky, black bears are destroyed after causing trouble a third time (referred to as the three strikes rule). Thus, releasing these bears in Robinson Forest was viewed as a last effort to avoid destroying them. As far as is known, all three individuals (each with three strikes) left the forest immediately after being released. One of these bears committed its "third strike" by raiding bee hives 50 km to the east of Robinson Forest in Martin County. It was transported and released in Robinson Forest, but immediately returned to the bee hives in Martin County (W. Marshall, pers. com.).

Cervidae
Cervus elaphus nelsoni V. Bailey, 1935
Elk

An effort to reintroduce elk into eastern Kentucky began in 1997 (Lankin et al., 2002; Maehr et al., 2002). The initial reintroduction was on reclaimed surface mines on the Cyprus-Amax Wildlife Management Area just outside the southern boundary of Robinson Forest in Knott and Perry counties. On 17 December 1997, nine elk were released. Additional releases occurred on 2 February, 1998 (54 elk), 22 February, 1998 (54 elk), 10 March, 1998 (51 elk), 26 February, 2000 (46 elk), 10 March, 2000 (29 elk), and 23 February, 2001 (55 elk). These animals were from Arizona, Kansas, and Utah (J. Larkin, pers. com). The current population around Robinson Forest is estimated at 170 animals (J. Larkin, pers. com.). The first hunting season for elk in Kentucky took place in the fall of 2001. The first elk shot were on the southern boundary of Robinson Forest.

During their first winter, some elk entered Robinson Forest. Since then most have remained on the reclaimed surface mines to the north and south of the forest. Individuals do occur in the forest as they move between the two sites. On the morning of 9 March, 2001, approximately 40 elk grazed in the Engineering Bottom for 2 hours. Currently, only one cow is known to have calved within the forest (J. Larkin, pers. com.).

Odocoileus virginianus virginianus
Zimmermann, 1780
White-tailed deer

White-tailed deer were considered extirpated from Robinson Forest during the 1940s (Overstreet, 1984). In 1947, the Kentucky State Department of Fish and Wildlife Resources reintroduced deer into the forest. Barbour and Hardjasasmita (1966) reported a large population by the mid-1950s. The authors suggested that by 1966 the species had become rare and infrequently seen. They felt that poaching on the forest and over-hunting on surrounding land contributed to the second population decline. Poaching remains a problem in Robinson Forest; however, we regularly observe white-tailed deer. During 52 weekend trips, we saw a total of 49 deer on 24 of these trips (0.94 deer sightings per trip). We typically observed deer in the forest while driving the roads and jeep trails. Often deer stand in roads or feed in the wildlife clearings. On two occasions, we observed two does feeding in Camp Robinson (December 1993 and February 1994), and we have seen their prints in camp on other occasions. One 27 March, 1998, two does followed our trap line in a wildlife clearing and ate the oatmeal out of 10 Sherman live traps until we chased them off. While sitting on the bank of Buckhorn Creek in October 1992, K. Haskins was almost run over by a young buck fleeing from a beagle. The buck came within 1 m of Haskins before sharply angling off into the stream.

DISCUSSION

Additional species since preliminary checklist of 1966: Sixteen additional species have been documented since Barbour and Hardjasasmita (1966) published the initial checklist on the mammals of Robinson Forest. In all likelihood, eleven of these species have always been present but overlooked. They include the pygmy shrew, silver-haired bat, hoary bat, little brown myotis, northern myotis, woodchuck, eastern harvest mouse, woodland jumping mouse, Appalachian cottontail, mink, and eastern spotted skunk.

Four of the 16 species probably arrived at Robinson Forest on their own efforts since Barbour and Hardjasasmita (1966). These include the prairie vole, meadow vole, coyote, and black bear. Coyotes and meadow voles are the only two species currently established. Black bears appear to be transient in Robinson Forest. With populations increasing in Kentucky, black bears are likely to become established in Robinson Forest. Based on the single confirmed specimen, the prairie vole probably represents a transient that was never established in Robinson Forest. The elk is the only new, apparently established, species that was introduced.

Species in decline: Evidence suggests that three species in Robinson Forest have declined. These include the Allegheny woodrat, eastern gray squirrel, and southern bog lemming. The best quantitative evidence of decline is for the southern bog lemming. The large number of deserted middens suggests that Allegheny woodrats may be declining as well. In this case, no information is available on the size of past populations. Forest staff have reported that eastern gray squirrels were much more abundant from the 1930s to the 1960s. Unfortunately no quantitative data exist on the population size of eastern gray squirrels in Robinson Forest. The sharp increase in the number of gray squirrels sighted in 2001 further complicates our understanding of the population dynamics of this species. Nonetheless is seems highly improbable that poor mast production of oaks, hickories, and beech have occurred for the last 30 years. Many hypotheses have been generated to explain why Allegheny woodrats and eastern gray squirrels might be less abundant. These include forest fragmentation, successional state of the maturing forest, several successive years of mast failure, the arrival of coyotes, and possible increase in bobcats.

Extirpated species: We were unable to collect two species listed by Barbour and Hardjasasmita (1966). These include the golden mouse and muskrat. As we have discussed above, there was suitable habitat for muskrat in the 1950s and 1960s. This is no longer the case. Barbour and Hardjasasmita's (1966) inclusion of golden mice is even more curious. We have invested considerable effort trying to collect this species along Buckhorn Creek. Virtually no suitable habitat exists, although the habitat along the Buckhorn comes closest. It is possible that Barbour and Hardjasasmita's specimen was a transient from the south.

Historical species: Historically the red wolf (*Canis rufus*), mountain lion (*Felis concolor*), and river otter (*Lutra canadensis)* probably ranged over much of Kentucky. These species were extirpated from Kentucky in the late 1800s or early 1900s and may have been present in Robinson Forest. We know of no documented sightings of these three species on the land that became Robinson Forest. River otters were reintroduced at several locations in the state, although there are no plans to release them in Robinson Forest. the streams are not large enough to support otters. There is no discussion of reintroducing red wolves or mountain lions in the area.

Introduced and reintroduced native species: Besides the introduction of elk discussed above, three other efforts were made to introduce mammals in Robinson Forest. These include beaver, black bears, and white-tailed deer. The effort to introduce beavers in 1947 was an immediate failure due to lack of habitat. As discussed in the species account, the three problem black bears released into the forest did not stay, and no serious reintroduction efforts were carried out (but doing so has been discussed). The reintroduction of white-tailed deer in 1947 was successful, and this species remains abundant in the forest.

Exotic species: If we define exotic species as those with natural ranges outside North America, then only two exotics are known from Robinson Forest. Neither feral cats nor house mice are common, and both are primarily associated with human-made structures in Camp Robinson and the Engineering Bottom. Norway rats are a third exotic species found close to Robinson Forest. It is probable that they may occasionally enter Camp Robinson. Feral pigs (*Sus scrofa*) occur along the Kentucky-Tennessee border (Frederick, pers. com.). Efforts are being undertaken to track their movements. No sightings of feral pigs exist in Robinson Forest; nonetheless, this is an exotic species that could invade the forest. Currently, exotic mammals appear to have minimal impact on the ecology of Robinson Forest.

Possible species: Six species may occur in Robinson Forest or the adjacent reclaimed mines. These include the southeastern shrew (*Sorex longirostris*),

meadow jumping mouse (*Zapus hudsonius*), red fox (*Vulpes vulpes*), long-tailed weasel (*Mustela frenata*), least weasel (*Mustela nivalis)*, and Norway rat (*Rattus norvegicus*). Reclaimed surface mines have created ideal habitat for the red fox; thus, it is likely that this species occurs around the boundary of Robinson Forest. Forest staff have described what appeared to be long-tailed weasels in the past. It is quite likely this species is in the forest, but we have failed to trap it. Forest staff have observed "rats" in Camp Robinson from time to time. The description fits that of *Rattus* more so than *Neotoma*, which has never been documented as occurring in camp. It is likely that Norway rats occasionally move up along Buckhorn Creek into Camp Robinson. This species probably follows the scattered houses and outbuildings with livestock along the stream. It is possible that *Sorex longirostris* occurs in Robinson Forest. An abundance of specimens were recorded from neighboring counties to the north, west, and south of Robinson Forest (Meade, 1992; Thomas 1994). In fact, Thomas (1994) found this to be the most abundant shrew in forest habitat in Madison County to the west of Robinson Forest. The least weasel will most likely arrive in the clearings of Robinson Forest before long. This species appears to have invaded the state from the north in the early 1980s and has since been recorded from numerous counties in north-central Kentucky, including counties within 50 km of the forest. Thomas (pers. com.) and Houtcooper (1982) have reported meadow jumping mice from counties surrounding Robinson Forest including specimens from Breathitt and Knott counties. The limited number of clearings with native grasses may be the main factor preventing this species from being established in Robinson Forest.

Species influenced by surface mining: Little quantitative data exist documenting how surface mining and subsequent reclamation influenced the mammals of Robinson Forest. Krupa and Haskins (1996) suggested the current dominance of meadow voles and brief presence of prairie voles were the result of reclaimed mines serving as dispersal corridors into the forest. They further suggested that the arrival of the competitively superior meadow vole caused the decline of the southern bog lemming. Further, the large number of sites with deserted Allegheny woodrat middens suggests that a larger population of this species once existed. If this is the case, the surface mining and resulting forest fragmentation may have isolated the population. Because Robinson Forest is marginal habitat for Allegheny woodrats (Krupa et al., in prep.), individuals from higher quality habitat may no longer disperse into the forest.

Extensive reclamation efforts have clearly provided suitable habitat for coyotes, eastern cottontails, elk, meadow voles, and prairie voles. Sole (1997) suggested that the mixture of open grass and early successional forest associated with older reclaimed sites might favor Appalachian cottontails. Whitaker (1988) suggested that populations of bobcats increased in reclaimed surface mines due to increase in prey. This is supported by the higher abundance of prey such as eastern cottontails and bobwhite (*Colinus virginianus*). Finally, forest staff have suggested that bobcats have become more common as surface mining has surrounded the forest. An increase in the bobcat population could have an effect on rodents of Robinson Forest. Similarly, the abundance of prey should favor higher populations of both the gray fox and red fox as was observed elsewhere (Yeager, 1942).

Forest management plans for higher mammal diversity: Maintaining a high diversity and abundance of mammals in Robinson Forest depends on several factors. As the forest naturally matures to a climax, mixed-mesophytic forest community, standing dead trees and tree falls will increase. This will produce more shelter for species such as gray squirrels and flying squirrels. A greater range in tree age classes and abundance of each age class will maintain a diversity of microhabitats within the forest. Further, establishing and maintaining wildlife clearings with native warm-season grasses is essential to maintaining the small mammal species such as southern bog lemmings and eastern harvest mice. In February 2001, four 2-hectare shelterwood cuts were established along Roaring Fork for an American chestnut reintroduction project (Fig. 1), with more clearings planned in 2002. This will establish novel habitats and create a more diverse habitat mosaic. Currently, forest management practices are not established with a conservation perspective (Muller and Maehr, 2000) or with the intention of shaping mammal communities.

Conclusions: The mammal fauna of Robinson Forest appears to be in a dynamic state. Unfortunately, little quantitative data exist to support this. We know little of how the abundance and diversity of mammals have changed. Regardless, qualitative information strongly indicates that significant changes have occurred. Current shifts may be due to climatic change, surface mining, fire, forest management practices, introduction of new species, and new species expanding their ranges. It is vital to conduct long-term studies that quantify ecological parameters. It is probable that Robinson Forest is and will continue to be in a dynamic state. This study provides a quantitative foundation so that future studies will have a reference point for comparison. This will provide an opportunity to document changes in the composition of mammals in Robinson Forest due to climatic changes, political factors, or disturbances from mining coal and drilling for natural gas.

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APPENDIX I

Museum specimens from Robinson Forest collected during this study (from 1992 to 2001) and by other researchers before 1992. All specimens currently housed at the University of Kentucky and final deposition will be in the University of Kansas Natural History Museum.

	Before 1992	After 1992	Other
Didelphis virginiana	1		
Blarina brevicauda	15	16	
Parascalops breweri	1	6	
Sorex fumeus		8	
Sorex hoyi	1	1	
Corynorhinus rafinesquii	4	3	
Eptesicus fuscus	3	1	
Lasionycteris noctivagans		2	
Lasiurus borealis	4	4	
Lasiurus cinereus		1	
Myotis lucifugus		1	
Myotis septentrionalis		2	
Pipistrellus subflavus	8	2	
Sylvilagus floridanus	1	4	
Microtus pennsylvanicus	4	30	
Microtus ochragaster	1		
Microtus pinetorum	21	4	
Mus musculus		1	
Neotoma magister	1	1	
Peromyscus leucopus	51	31	
Reithrodontomys humulis		8	
Synaptomys cooperi	19	5	
Glaucomys volans	1	5	
Sciurus carolinensis	1		
Tamias striatus	8		
Napaeozapus insignis	2		
Urocyon cinereoargenteus		2	
Felis catus		3	
Mephitis mephitis		2	
Spilogale putorius			1*
Procyon lotor		2	
Cervus elaphus		2	
Odocoileus virginianus		4	

* Photograph

APPENDIX II

Characteristic vegetation identified in major habitats of Robinson Forest.

Low-elevation clearings

Grass-dominated

Cyperaceae	Sedge family
Cyperus strigosus	False nutsedge
Juncaceae	Rush family
Juncus effusus	Common rush
Poaceae	Grass family
Agrostis perennans	Autumn-bentgrass
Andropogon virginicus	Broom-sedge
Digitaria ischaemum	Smooth crab-grass
Festuca elatior	Tall fescue
Microstegium uminium	Camus
Panicum rigidulum	Redtop panic grass
Panicum virgatum	Switch grass
Panicum anceps	Flat-stemmed panic grass
Panicum dichotomum	Bushy panic grass
Tridens flavus	Purpletop
Triodia flava	Tall redtop
Polygonaceae	Smartweed family
Polygonum cespitosum	Long-bristled smartweed
Polygonum sagittatum	Arrowleaf tear thumb
Rosaceae	Rose family
Potentilla canadensis	Canada cinquefoil
Solanaceae	Nightshade family
Solanum carolinense	Horse-nettle
Urticaceae	Nettle family
Boehmeria cylindrica	False nettle

Herb-dominated

Asteraceae	Aster family
Aster prenanthoides	Zig zag aster
Elephantopus carolinianus	Elephant's foot
Vernonia gigantea	Tall ironweed
Solidago rugosa	Goldenrod
Anaphalis magaritacea	Pearly everlasting
Cyperaceae	Sedge family
Carex sp.	Sedge
Juncaceae	Rush family
Juncus sp.	Rush
Poaceae	Grass family
Panicum dichotomiflorum	Common name not known
Digitaria ischaemum	Smooth crab-grass
Polygonaceae	Smartweed family
Polygonum cespitosum	Long-bristled smartweed
Polygonum sagittatum	Arrow-leaved tearthumb
Solanaceae	Nightshade family
Solanum carolinense	Horse-nettle

Appendix II. (continued).

High-elevation clearing

Aceraceae	Maple family
Acer rubrum	Red maple
Fabacaea	Pea family
Lespedeza bicolar	Bicolored lespedeza
Fagaceae	Beech family
Quercus prinus	Chestnut oak
Magnoliaceae	Magnolia family
Liriodendron tulipifera	Yellow-poplar
Pinaceae	Pine family
Pinus strobus	Eastern white pine
Pinus virginiana	Virginia pine
Platanaceae	Sycamore family
Platanus occidentalis	Sycamore
Poaceae	Grass family
Andropogon virginicus	Broom-sedge
Rosaceae	Rose family
Rubus sp.	Bramble

Mixed-mesophytic forest

Low-elevation mesic forest

Aceraceae	Maple family
Acer rubrum	Red maple
Acer saccharum	Sugar maple
Betulaceae	Birch family
Betula nigra	River birch
Ericaceae	Heath family
Rhododendron maximum	Rosebay rhododendron
Fagaceae	Beech family
Fagus grandifolia	American beech
Quercus alba	White oak
Quercus rubra	Northern red oak
Quercus velutina	Black oak
Juglandacaea	Walnut family
Carya ovata	Shagbark hickory
Carya tomentosa	Mockernut hickory
Magnoliaceae	Magnolia family
Liriodendon tulipifera	Yellow-poplar
Magnolia acuminata	Cucumbertree
Oleaceae	Olive family
Fraxinus americanus	White ash
Pinaceae	Pine family
Tsuga canadensis	Eastern hemlock
Tiliaceae	Basswood family
Tilia americana	American basswood

Appendix II. (continued).

Mid-elevation transitional forest

Aceraceae	Maple family
Acer rubrum	Red maple
Ericaceae	Heath family
Oxydendrum arboreum	Sourwood
Fagaceae	Beech family
Fagus grandifolia	American beech
Quercus alba	White oak
Quercus coccinea	Scarlet oak
Quercus prinus	Chestnut oak
Quercus rubra	Northern red oak
Quercus velutina	Black oak
Juglandacaea	Walnut family
Carya glabra	Pignut hickory
Carya ovata	Shagbark hickory
Carya tomentosa	Mockernut hickory
Magnoliaceae	Magnolia family
Liriodendon tulipifera	Yellow-poplar
Magnolia acuminata	Cucumbertree
Nyssaceae	Sourgum family
Nyssa sylvatica	Blackgum
Oleaceae	Olive family
Fraxinus americana	White ash
Pinaceae	Pine family
Tsuga canadensis	Eastern hemlock
Tiliaceae	Basswood family
Tilia americana	American basswood

High-elevation xeric forest

Aceraceae	Maple family
Acer rubrum	Red maple
Fagaceae	Beech family
Quercus alba	White oak
Quercus coccinea	Scarlet oak
Quercus prinus	Chestnut oak
Quercus velutina	Black oak
Juglandacaea	Walnut family
Carya glabra	Pignut hickory
Pinaceae	Pine family
Pinus echinata	Shortleaf pine
Pinus rigida	Pitch pine
Pinus virginiana	Virginia pine

Appendix II. (continued).

Reclaimed surface mines

Fescue-dominated slopes

Fabaceae	Legume family
Coronilla varia	Crowned vetch
Robinia pseudoacacia	Black locust
Poaceae	Grass family
Argostis gigantea	Redtop
Festuca arundinacea	Tall fescue (Kentucky 31-tall fescue)
Panicum dichotomiflorum	Spreading witch grass

Xeric habitat dominated by legumes

Anacardiaceae	Cashew family
Rhus glabra	Smooth sumac
Asteracea	Aster family
Eupatorium serotinum	Late eupatorium
Solidago canadensis	Common goldenrod
Fabaceae	Legume family
Cercis canadensis	Eastern redbud
Lespedeza bicolor	Bicolored lespedeza
Lespedeza cuneata	Chinese lespedeza
Lespedeza stiata	Japanese clover
Lespedeza stipulacea	Korean clover
Lespedeza violacea	Violet lespedeza
Robinia pseudoacacia	Black locust
Elaeagnaceae	Oleaster Family
Elaeagnus umbellata	Autumn olive
Poaceae	Grass family
Argostis gigantea	Redtop

Xeric habitat dominated by grasses, asters, and legumes

Asteraceae	Aster family
Anaphalis margaritacea	Pearly everlasting
Aster pilosus	Awl aster
Conyza canadensis	Horseweed
Solidago canadensis	Common goldenrod
Fabaceae	Legume family
Lespedeza cuneata	Chinese lespedeza
Lespedeza stipulacea	Korean clover
Lespedeza striata	Japanese clover
Lotus corniculatus	Birdsfoot-trefoil
Robinia pseudoacacia	Black locust
Trifolium pratense	Red clover
Poaceae	Grass family
Andropogon virginicus	Broom-sedge
Argostis gigantea	Redtop
Panicum dichotomiflorum	Spreading witch grass
Tridens flavus	Purpletop
Polygonaceae	Smartweed family
Polygonum cespitosum	Long-bristled smartweed
Rosaceae	Rose family
Rubus sp.	Bramble

Appendix II. (continued).

Mid-elevation transitional forest

Aceraceae	Maple family
Acer rubrum	Red maple
Ericaceae	Heath family
Oxydendrum arboreum	Sourwood
Fagaceae	Beech family
Fagus grandifolia	American beech
Quercus alba	White oak
Quercus coccinea	Scarlet oak
Quercus prinus	Chestnut oak
Quercus rubra	Northern red oak
Quercus velutina	Black oak
Juglandacaea	Walnut family
Carya glabra	Pignut hickory
Carya ovata	Shagbark hickory
Carya tomentosa	Mockernut hickory
Magnoliaceae	Magnolia family
Liriodendon tulipifera	Yellow-poplar
Magnolia acuminata	Cucumbertree
Nyssaceae	Sourgum family
Nyssa sylvatica	Blackgum
Oleaceae	Olive family
Fraxinus americana	White ash
Pinaceae	Pine family
Tsuga canadensis	Eastern hemlock
Tiliaceae	Basswood family
Tilia americana	American basswood

High-elevation xeric forest

Aceraceae	Maple family
Acer rubrum	Red maple
Fagaceae	Beech family
Quercus alba	White oak
Quercus coccinea	Scarlet oak
Quercus prinus	Chestnut oak
Quercus velutina	Black oak
Juglandacaea	Walnut family
Carya glabra	Pignut hickory
Pinaceae	Pine family
Pinus echinata	Shortleaf pine
Pinus rigida	Pitch pine
Pinus virginiana	Virginia pine

Appendix II. (continued).

Hydric habitat dominated by cattail, rushes, and sedges

Cyperaceae	Bullrush family
Scirpus cyperinus	Bullrush
Juncaceae	Rush family
Juncus sp.	Rush
Poaceae	Grass family
Andropogon virginicus	Broom-sedge
Argostis gigantea	Redtop
Panicum dichotomiflorum	Spreading witch grass
Tridens flavus	Purpletop
Typhaceae	Cattail family
Typha sp.	Cattail

Appendix II. (continued).

Reclaimed surface mines

Fescue-dominated slopes

Fabaceae	Legume family
Coronilla varia	Crowned vetch
Robinia pseudoacacia	Black locust
Poaceae	Grass family
Argostis gigantea	Redtop
Festuca arundinacea	Tall fescue (Kentucky 31-tall fescue)
Panicum dichotomiflorum	Spreading witch grass

Xeric habitat dominated by legumes

Anacardiaceae	Cashew family
Rhus glabra	Smooth sumac
Asteracea	Aster family
Eupatorium serotinum	Late eupatorium
Solidago canadensis	Common goldenrod
Fabaceae	Legume family
Cercis canadensis	Eastern redbud
Lespedeza bicolor	Bicolored lespedeza
Lespedeza cuneata	Chinese lespedeza
Lespedeza stiata	Japanese clover
Lespedeza stipulacea	Korean clover
Lespedeza violacea	Violet lespedeza
Robinia pseudoacacia	Black locust
Elaeagnaceae	Oleaster Family
Elaeagnus umbellata	Autumn olive
Poaceae	Grass family
Argostis gigantea	Redtop

Xeric habitat dominated by grasses, asters, and legumes

Asteraceae	Aster family
Anaphalis margaritacea	Pearly everlasting
Aster pilosus	Awl aster
Conyza canadensis	Horseweed
Solidago canadensis	Common goldenrod
Fabaceae	Legume family
Lespedeza cuneata	Chinese lespedeza
Lespedeza stipulacea	Korean clover
Lespedeza striata	Japanese clover
Lotus corniculatus	Birdsfoot-trefoil
Robinia pseudoacacia	Black locust
Trifolium pratense	Red clover
Poaceae	Grass family
Andropogon virginicus	Broom-sedge
Argostis gigantea	Redtop
Panicum dichotomiflorum	Spreading witch grass
Tridens flavus	Purpletop
Polygonaceae	Smartweed family
Polygonum cespitosum	Long-bristled smartweed
Rosaceae	Rose family
Rubus sp.	Bramble